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**IFPRI Discussion Paper 00815**

November 2008

**Migration and Technical Efficiency in Cereal Production**

Evidence from Burkina Faso

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## ABSTRACT

This paper uses data envelopment analysis and new data from Burkina Faso to test the impact of intercontinental and continental migration on technical efficiency in the production of two cereals—millet and sorghum—by rural households. Econometric evidence supports our theoretical expectation that the impact of emigration varies by migrant destination. I find evidence of a positive relation between continental migration and technical efficiency and a negative relation between intercontinental migration and technical efficiency. In an imperfect market environment, continental migration is associated with greater efficiency because it removes a male labor surplus; explanations for the negative relationship between intercontinental migration and technical efficiency should be sought in a surplus of female labor supply. Overall, findings suggest that migration does not lead to a transformation of cereal production from traditional to modern, because in an imperfect market environment, liquidity received in the form of remittances cannot compensate for labor shortfalls.

**Keywords:** migration, rural households, West Africa, data envelopment analysis



# 1. INTRODUCTION

Burkina Faso, a country where agricultural conditions are far from favorable, has a long history of migratory movement. Migration within West Africa has long taken place in response to drought and low agricultural productivity; it became institutionally induced during colonial times, when labor was needed in mines and on plantations in places such as Côte d'Ivoire. Over the past decades, migration to destinations outside Africa—in particular, to Western Europe—has become more important for migrants from Burkina Faso (Adepoju 1977; Arthur 1991; Findley 1997; Yusuf 2003).

Migration as a household diversification strategy has received much attention from researchers and policymakers, mostly due to its consequences for development. The interactions among migration, remittances, and development have been topics for debate in recent years. Consequences of migration for rural households are usually thought to be one of two extremes. On the one extreme, there is the optimistic perspective associated with the new economics of labor migration (NELM). According to NELM, migration and remittances, as part of a household's strategy to raise income, investment funds, and insurance protection, can promote development by loosening production and investment constraints. On the other extreme is a more pessimistic approach that emphasizes the "Dutch disease" effect, which views migrant activities as a drain on the labor and capital (including human capital) resources of migrant-sending areas. According to this latter view, migration competes with local production. Advocates of this position argue that per capita incomes in migrant-source regions can actually fall when migrants leave. Migration might reduce income in migrant-sending areas if the marginal production of the migrant's labor is large prior to migration and/or if migrants take productive capital (including human capital) with them upon their departure. Migrant remittances may only partially compensate for these lost-labor and lost-capital effects (Taylor and Fletcher 2007).

This study uses econometric methods and new survey data from Burkina Faso to explore ways in which migration influences the production of millet and sorghum. This study contributes to the migration remittances development debate by taking into account a number of novel issues. First, the implications of the NELM are that in the absence of perfect markets, other sources of household income will be influenced by migration (Stark 1991). For rural households in Burkina Faso, cereals constitute an important source of subsistence. Migration is likely to influence cereal production for several reasons. In the absence of a perfect labor market, the removal of labor could make it difficult, if not impossible, for households to meet labor demand and thus could lead to a decline in output. Remittances could help overcome labor shortfalls by providing households with a source of liquidity that can be used for investments in labor-substituting inputs. In addition, remittances as a source of liquidity can be used to purchase additional inputs.

Second, studies on migration often consider migration to be a homogeneous act, and yet different forms of migration often can and should be distinguished. Following Adams's (1998) work on Pakistan, we propose that instead of a general concept of migration, two different forms of migration need to be distinguished in West Africa: migration within the African continent (continental migration) and migration to a destination outside Africa (intercontinental migration). Although intercontinental migration generates a high level of remittances, high entry costs imply that not all households can engage in this form of migration.

Third, studies on migration often limit themselves to analyzing how remittances are spent. Given the fungibility of money and the fact that household expenditures are actually shaped by consumption preferences and constrained by household budgets, a more comprehensive approach is needed to correctly estimate the impact of migration on rural households. The central difference between households with migrants and those without is the relative availability of labor and finance. An analysis of household technical efficiency in the production of millet and sorghum sheds light on the importance of labor and financial liquidity for agricultural production. A finding of higher technical efficiency among households supplying migrants would imply better allocation of production factors. In contrast, higher technical efficiency in nonmigrant farms would suggest that labor migration is currently detrimental to agricultural

production (Mochebelele and Winter-Nelson 1999). When a further distinction is made within migrant households into continental and intercontinental migration, findings for technical inefficiency are likely to sketch a more complex story.

This paper uses nonparametric analysis to obtain output-based measures of technical efficiency of farm households. A Tobit model is subsequently used to analyze factors affecting the efficiency indices, including incidence of continental or intercontinental migration in the household. Our findings suggest that continental migration has a positive relation and intercontinental migration a negative relation with farm technical efficiency. For households with continental migrant households, migration has removed a surplus of male labor, thereby removing a cause for inefficiency in production. Intercontinental migration appears to lead to a gender imbalance in the household, with negative implications for production efficiency. The failure of intercontinental migration to transform cereal production from traditional to modern is attributed to an imperfect market environment.



## 2. MIGRATION AND CEREAL PRODUCTION

Two important effects of migration—earnings in the form of remittances and a loss of labor—are likely to lead to changes in agricultural production, though in terms of income from agriculture, these two effects can offset each other. Jokisch (2002) finds for the Ecuadorian Andes that land use and agricultural production of international migrant households are not significantly different from nonmigrant households. He concludes that agriculture is not abandoned, even though investments in agriculture are not made. His case study appears to suggest that a middle path is followed by households that continue to practice agriculture because it reduces costs of food procurement, guarantees a degree of economic independence, and is important from a cultural perspective. However, in-depth investments in cultivation are not made due to poor environmental quality and low returns on cultivated crops. When agricultural innovation does not take place, agricultural practices of migrant households may become stagnant in the long run.

Consequences of migration, such as labor scarcity and/or the household relying on remittances as an income source, can cause inadequate attention to be paid to agriculture, which can lead to environmental degradation. Black (1993) finds for two counties in northern Portugal that migration has led to a reduction in the size of the herd and to the application of poorer-quality forms of manure, among other things. In addition, he finds evidence that migrant households abandon certain conservation practices that had previously helped maintain levels of production and soil fertility.

Changes in input use due to migration may affect technical efficiency in agricultural production. Low (1986) argues for Southern Africa that inefficiency in production would increase with migration, because the departure of young, educated adult male members would lead to changes in the quality and quantity of the household labor force. According to Palmer (1985), migration in Southern Africa reduces farm output and women's welfare, in particular, due to the loss of male labor. For Burkina Faso, where the extended farm household structure implies that the wives of migrants will continue to live in the compound of their husbands and fall under the authority of the head of household, usually their father-in-law (David 1995), the reduction in availability of the household labor force is perhaps less severe. However, production may also be affected by the loss of male labor to migration when males and females fulfill gender-specific complementary tasks.

Migration can also lead to an increased workload for the remaining household members, possibly implying that not all agricultural tasks can be carried out. It has been reported that the effects of international migration tend to be more severe compared with those of national migration. Mines and de Janvry (1982) find for Las Animas, Mexico, that U.S.-oriented migration leads to more neglect of the village economy as compared with internal migration. They attribute this neglect to the more permanent character of international migration, of which the resulting remittances were found not to be used for investment, productive ventures, or agricultural improvement. Kuiper (2005) finds for China that an increase in outside province migration, which has a more permanent character, induces households to change from two-season to one-season rice, which is less labor intensive.

For Africa, Hyden, Kates, and Turner (1993) find no general tendency of migration halting agricultural intensification or giving rise to stagnation, though they do find that remittances are rarely used for capital investments in agriculture. Given the fungibility of money, however, a direct analysis of remittance use may not yield adequate insights into the consequences of migration for agriculture. They conclude that many households experience diminished agricultural production and display inadequate land improvements, primarily due to the absence of male labor, but also point to large regional variations in impacts. An analysis of technical efficiency in rural Lesotho by Mochebelele and Winter-Nelson (2000) suggests that remittances facilitate, rather than substitute for, agricultural production.

Gubert (2002) developed a theoretical rent-seeking model to explain the relationship between migration and agricultural production. In this model, remittances are part of a contractual arrangement between the migrants and the remaining household members. This arrangement rests on a sense of distributive justice. A clause in the contract binds the migrants to remit funds each time their households

cannot establish entitlement over an adequate amount of food through either purchase or production. Imperfect monitoring of effort implies that migrants cannot ascertain whether low yields produced by the household are due to their relatives' idleness or an unfavorable state of nature. It may thus induce the household to shirk and to rely on migrants for subsistence. When testing this model for Mali, Gubert finds that the probability of being financially supported by migrants significantly contributes to technical inefficiency in cereal production.

The distinction that is relevant for the current discussion is not just between migrant and nonmigrant households, but also among nonmigrant, continental migrant, and intercontinental migrant households. Differences in technical efficiency among the three groups of households would suggest that there are options to improve agricultural output using existing production technologies and that rigidities in factor markets may constrain management to differing degrees based on household supplies of labor or finance (Mochebelele and Winter-Nelson 2000).

### 3. DATA AND STUDY AREA

Data to test the impact of continental and intercontinental migration on household welfare are from a household survey conducted by the author in a number of villages in Burkina Faso in 2003. Two villages, Niaogho and Béguédo, were selected for this particular analysis, because the incidence of both continental and intercontinental migration in these villages makes it possible to compare implications of migration for cereal production in a similar environmental setting. Niaogho and Béguédo are situated next to each other in the south of the Central Plateau, which constitutes the central region of Burkina Faso.

Cross-section data on sociodemographic characteristics and production and consumption activities were gathered from a random sample of 60 households in Niaogho and 43 households in Béguédo. Households were selected as randomly as possible in the absence of any preexisting census maps. This selection process first entailed determining the layout of a village. Subsequently, each enumerator was sent out in a different direction to select households at an equal distance from one another, ensuring that all peripheral areas were covered. Although an attempt was made to interview several household members, in practice, the head of the household, who was found to be male in all cases, answered most of the questions.

Although sample households within villages were randomly selected, the localized nature of intercontinental migration to Europe necessitated purposeful selection of the survey villages. This purposeful selection and the small sample size limit the study's representativeness; an investigation of about a 100 households in two villages does not enable countrywide policy implications to be drawn. Findings are specific for the Burkina Faso's Central Plateau, which is distinct for its high population density, land degradation, and history of outmigration.

Subsistence cropping is the primary activity of the households we surveyed. This cropping results in the production of cereals, primarily sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*). Cropping on the Central Plateau is rain fed and characterized by a single short cropping season each year.<sup>1</sup> Soils in Niaogho and Béguédo are chemically poor with high vulnerability to erosion (Kessler and Geerling 1994). Labor productivity in staple cropping tends to be low, with little investment in fertilizer and limited application of manure. Crop production is often combined with livestock keeping. Households derive income from livestock mainly through embodied production, or an increase in weight or herd size. Other functions of livestock—cattle, in particular—include transportation and traction. Livestock manure is also an input in agricultural production, and cattle, in particular, represents an important capital asset. In addition to staple cropping and livestock, many households engage in horticultural activities, cultivating mainly onions on waterside plots.

The economic activities of the households in the study villages should be viewed in a context of missing or imperfect markets. Three missing or imperfect markets are identified: labor, land, and credit or insurance. The households make virtually no use of hired labor on their farms. In fact, working on someone else's field in order to earn revenue is looked upon negatively as a sign of inability to sustain one's household with one's own agricultural production (Mazzucato and Niemeijer 2000). Households do resort to a form of exchange labor, but only at a specific time for a specific crop (i.e., onion cultivation on waterside plots). Land markets in rural Africa often barely function and are generally quite thin (Lanjouw, Quiznon, and Sparrow 2001). For Burkina Faso, in general, commercial land market transactions are extremely rare (Ouedraogo et al. 1996). In the study villages, where high population density has led to land scarcity as elsewhere on the plateau (Kessler and Geerling 1994), not a single land transaction was recorded in the data. The lack of commercial land market transactions implies that land cannot function as collateral for credit. Restricted options for collateral and collateral substitutes mean that households face severe limitations in accessing a formal credit market.

Uncertainty, combined with missing markets for risk, creates incentives to diversify income-generating activities. Diversification of activities enables households to reduce the risk they face by

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<sup>1</sup> Annual rainfall in Boulgou province, where Niaogho and Béguédo are located, is between 700 and 800 mm.

generating income from sources not correlated with cropping income. Households in the study area diversify their income by engaging in migration and nonfarm activities. In both villages, household members engage in migration, with approximately 64 percent of the surveyed households having one or more migrant in 2002. Household members were classified as migrants if they had been absent from the household for more than a month during the year. Migrants were included as household members if they were included in the household inventory by the head of the household.<sup>2</sup> Household members who migrate were found to almost always stay away for more than one year. Information on migrants who were away at the time of the survey was supplied by the head of the household. This information included duration of absence, destination, reasons for migrating, and remittances sent back to the household.

The village surveys reveal two principal types of migrant destination: continental and intercontinental.<sup>3</sup> Continental migrants are generally young men who attempt to find work elsewhere on the African continent. Until recently, the primary destination of continental migrants from the surveyed villages was Côte d'Ivoire. However, the migrant flow to Côte d'Ivoire has all but vanished, due to the nation's unstable political situation, ethnic tensions, and antiforeigner sentiment. Many Burkinabé now migrate to the capital of their country, Ouagadougou. In nearly all cases, intercontinental migration from Niaogho and Béguédo comprises young (Bissa) males who go to Italy, initially to engage in horticulture around Naples. As is evident from the high income share shown in Table 1, intercontinental migration is highly lucrative in terms of remittances sent back to the household; however, it involves high entry costs, particularly for transportation. Continental migration is less costly but generates comparatively few remittances.<sup>4</sup>

**Table 1. Per capita income by source and migration status, 2002**

	Nonmigrant (N = 38)	t-test means <sup>a</sup>	Continental migrant (N = 35)	t-test means <sup>b</sup>	Intercontinental migrant (N = 30)
Total income (in FCFA) <sup>c</sup>	38,670	0.30	37,495	-3.04	67,428
Staple cropping	17,341 (12,247) <sup>d</sup>	1.16	14,361 (11,112)	-0.46	18,951 (11,710)
Cash cropping	7,976 (8,618)	0.29	7,408 (13,335)	0.81	6,671 (6,683)
Livestock	1,344 (6,618)	-0.58	2,485 (7,679)	-1.34	4,233 (9,133)
Nonfarm activities	12,009 (21,115)	0.75	9,189 (12,593)	0.88	8,104 (15,973)
Remittances			4,050 (7,093)		29,470 (29,680)

Notes: <sup>a</sup> nonmigrant versus continental migrant households

<sup>b</sup> nonmigrant versus intercontinental migrant households

<sup>c</sup> 168 (Franc Communauté Financière Africaine) (FCFA) = \$1 [purchasing power parity (PPP) 2002] (World Bank 2005)

<sup>d</sup> standard deviation in parentheses

In addition to agriculture and migration, households derive income from nonfarm activities. These tend to be self-employment activities and not wage labor, because a labor market does not exist in the surveyed villages.<sup>5</sup> Important activities of women include food preparation and sales, whereas men engage in a number of artisan activities. Most nonfarm activities are intensive in labor but not in capital, though a small number of households do engage in high-return commercial activities. Table 1 shows that although income derived from staple crop production does not differ between groups, its share in total

<sup>2</sup> Women who left the household upon marriage were not considered as migrants.

<sup>3</sup> Within the group of continental migrants, a t-test reveals that remittances of migrants within and outside Burkina Faso (but within Africa) do not differ significantly, supporting the joining of these forms of migration into one group.

<sup>4</sup> There are only a limited number of observations on costs of migration. Households spent about 200,000 FCFA (Franc Communauté Financière Africaine) per intercontinental migrant and between 3,000 and 7,000 FCFA per continental migrant.

<sup>5</sup> Most nonfarm activities were found to take place in the dry season.

income falls for households with intercontinental migrants that receive a large amount of remittance income.

In both villages, millet and sorghum are generally cultivated under traditional crop management practices, in which farmers use little external inputs, such as purchased seed and inorganic fertilizer.<sup>6</sup> Traditional crop management practices mean that labor, in particular, is strongly related to output. A missing market for labor implies that hired labor is not used in cereal production. Table 2 shows that differences exist in farm characteristics by migration status. Intercontinental migrant household farms are significantly larger in terms of land used for cereal cropping compared with the farms of nonmigrant and continental migrant households. Differences also exist in terms of labor availability. Nonmigrant households have more males than females per hectare. In addition, for continental migrant households, the number of males and females per hectare is equal, whereas for intercontinental migrant households, there are more females per hectare. Spending on inputs is similar across household groups, as is harvest per hectare.

In addition to input use, farming practices are largely determined by equipment use. Animal traction, in particular, should be considered a labor-saving technology device during the preparation and planting stage (Pingali, Bigot, and Binswanger 1989). In the two villages, a rented tractor is often used during the harvesting stage, especially of millet. The use of animal traction along with the tractor in staple crop cultivation should give an indication to the extent to which labor can be substituted. Table 2 shows that animal traction is most extensively used by households with intercontinental migrants.

**Table 2. Farm characteristics by migration status, 2002**

	Nonmigrant (N = 38)	t-test means <sup>a</sup>	Continental migrant (N = 35)	t-test means <sup>b</sup>	Intercontinental migrant (N = 30)
Land (ha)	2.27 (1.42) <sup>c</sup>	-0.32	2.39 (1.76)	-2.52	3.53 (2.63)
Household males (persons/ha)	1.61 (1.14)	-1.19	2.04 (1.87)	0.77	1.41 (0.99)
Household females (persons/ha)	1.30 (0.61)	-2.33	2.07 (1.82)	-2.18	1.83 (1.18)
Input cost (FCFA/ha) <sup>d</sup>	5913(5655)	-0.11	4694 (4402)	1.01	6069 (5734)
Plough (% of households)	42	-0.55	49	-5.67	97
Tractor (% of households)	82	0.81	71	-1.45	90
Harvest (kg/ha)	465 (157)	-0.33	486 (323)	-0.77	507 (250)

Notes: <sup>a</sup> nonmigrant versus continental migrant households

<sup>b</sup> nonmigrant versus intercontinental migrant households

<sup>c</sup> standard deviation in parentheses

<sup>d</sup> 168 FCFA = \$1 (PPP 2002) (World Bank 2005)

As mentioned, traditional cropping practices mean that labor, in particular, is strongly related to output. In the survey, labor input of household members in days was recorded for three stages of the production process: preparation and planting of the plot, crop maintenance, and harvesting.<sup>7</sup> Table 3 shows how migrant households differ in staple cropping for these three stages of the production process.

<sup>6</sup> Inputs as well as yields are statistically similar for millet and sorghum. The average market price in the two villages (derived from the survey) is 113 FCFA/kg for millet and 117 FCFA/kg for sorghum.

<sup>7</sup> Because data come from a single cross-section survey, measurement error due to heavy reliance on the ability of the producer to recall and report a frequently occurring, irregular event such as labor input may be substantial. However, separate recording of labor input during the three stages of the production process ensures that major variation in labor input over the annual cycle is captured.

**Table 3. Labor input in days per hectare by migration status, 2002**

	Nonmigrant (N = 38)	t-test means <sup>a</sup>	Continental migrant (N = 35)	t-test means <sup>b</sup>	Intercontinental migrant (N = 30)
Male preparation & planting	23 (27) <sup>c</sup>	0.59	20 (25)	1.62	15 (14)
Female preparation & planting	16 (12)	-0.83	20 (31)	-1.89	22 (17)
Male crop maintenance	71 (59)	1.84	46 (54)	2.78	38 (31)
Female crop maintenance	54 (42)	-0.12	47 (50)	0.60	48 (34)
Male harvesting	26 (36)	0.94	19 (27)	2.24	12 (12)
Female harvesting	15 (10)	-1.22	22 (29)	-1.68	21 (16)
Total male	120		85		65
Total female	85		89		91

Notes: <sup>a</sup> nonmigrant versus continental migrant households

<sup>b</sup> nonmigrant versus intercontinental migrant households

<sup>c</sup> standard deviation in parentheses

Although crop maintenance is the most labor-intensive stage of the production process, migrant households scale back their input of male labor during this stage. According to Fafchamps (1993), farmers in Burkina Faso retain a significant amount of flexibility in their weeding (crop maintenance) decisions and adjust their weeding effort depending on information available at the time. Fafchamps asserts that a short agricultural season leads households to behave in particular ways in response to information. If, after planting, rains are poor so that weeds grow slowly, farmers compensate the expected reduction in yield by weeding more carefully. If rainfall is abundant so that weeds grow faster, farmers increase their weeding effort; however, due to the increased opportunity cost of labor, this increase is not proportional to weed infestation, which implies that yields do not reach their full potential. Although in a cross section, weeding effort cannot be analyzed over poor and good rainfall years, it should be clear that in the period under analysis, weeding effort changes with household migration status, whereas yields do not vary.

In considering differences in labor input between the two groups of migrant households, we find that whereas households with continental migrants use less male labor during the crop maintenance stage, as discussed above, households with intercontinental migrants use significantly less male labor during all three stages as compared with nonmigrant households. It is also important to note that for nonmigrant households, total labor input per hectare of males is higher than that of females; for continental migrant households, input of males and females is almost equal; and for intercontinental migrant households, labor input of males exceeds that of females.

Combining the data from Tables 2 and 3 allows us to postulate two hypotheses related to the relationship between cereal production and continental and intercontinental migration. A first hypothesis is that migrant households of either type do not follow a strategy of cereal cropping intensification. In other words, remittances do not lead households to invest more in inputs, though traction is more widely used among intercontinental migrant households and loss of male labor leads to more extensive cultivation in terms of labor input. The second hypothesis is that the effect of migration differs by destination of the migrant. Continental migration is associated with a balanced labor input of males and females, whereas intercontinental migration is associated with more use of female compared with male labor.

Technical inefficiency should be considered as a measure of management error, rather than income or gross output. Lower inefficiency does not correspond to greater yields or greater income. By applying fewer inputs in a consistent and timely manner, a “low input” farmer could achieve a better technical efficiency score than a farmer employing more inputs and achieving a higher yield. In this case, the “high input” farmer generates greater yields but does not come as close to the maximum possible yield from the inputs applied (Mochebelele and Winter-Nelson 2000).

There are a number of reasons that households with different migration statuses might differ in terms of efficiency. First, poverty or rigidities in factor markets may contribute to variations in technical inefficiency based on differential access to labor. When labor lost to migration cannot be replaced by hired labor, households with migrants might be at a disadvantage in their ability to adjust to intra-annual changes in farm conditions. Because timing is critical in agricultural production, knowledgeable and motivated farmers who are resource poor may be less able to apply inputs in a consistent manner than those who have greater access to resources (Mochebelele and Winter-Nelson 2000). For example, preparing and planting a particular area of land may be carried out in anticipation of access to an appropriate amount of weeding labor in the future. Because the amount of weeding required will depend on the volume and timing of rainfall, it is not possible to perfectly forecast how much labor the activity will require or when that labor will be needed (Fafchamps 1993). When weeding becomes necessary, households that are less able to mobilize sufficient labor rapidly are more likely to employ labor less effectively. Second, technical inefficiency might be exacerbated if access to remittances encourages resident household members to attend less to farm production and more to other activities. Because remittances are much larger for households with intercontinental migrants, production inefficiency may be expected to be higher for this group of households.

## 4 ANALYTICAL MODEL

Two main techniques are generally used to analyze agricultural production and farm efficiency. The parametric approach consists of specifying and estimating a parametric production function frontier, as proposed by Aigner, Lovell, and Schmidt (1977), and calculating technical inefficiency. A production frontier reflects the maximum obtainable output given a set of inputs; technical efficiency, in this case, relates the proximity of a farm household's output to this maximum feasible output (Coelli, Rahman, and Thirtle 2002). Although this approach provides a convenient framework for conducting hypothesis testing, the results can be sensitive to the parametric form chosen (Chavas, Petrie, and Roth 2005). A nonparametric approach has the advantage of removing the necessity of making arbitrary assumptions regarding the functional form of the frontier and the distributional form of the error. A second advantage of the nonparametric approach is that it is relatively less data demanding and thus works well with small samples, as compared with the parametric approach. However, a major drawback is that because the nonparametric method is deterministic and attributes all the variation from the frontier to inefficiency, the frontier it estimates is likely to be sensitive to measurement errors or other noise in the data. In particular, efficiency tends to be overpredicted in finite samples.

A farm household model, in which household members make production, consumption, and labor allocation decisions during a specific period, forms the basis for the analysis. To generate income, the household uses household labor ( $L$ ), variable inputs ( $V$ ), and fixed inputs ( $A$ ), including land, to produce millet or sorghum. The technology facing the household is represented by the feasible set  $X$ , where

$$(V, L, A; Q) \in X \quad (1)$$

means that inputs  $V$ ,  $L$  and  $A$  can feasibly produce output  $Q$ .

Chavas, Petrie, and Roth (2005) argue that in an imperfect market environment, the appropriate level of production efficiency analysis is the household. A general technology for different production activities allows for joint household decisions between farm and nonfarm activities. Examples of jointness include skills acquired in nonfarm employment that improve farm management and nonfarm income that reduces the adverse effects of credit market imperfections on farm decisions. For the households in our analysis, however, jointness between farm and nonfarm activities may not be that strong. First, as mentioned, nonfarm activities mainly take place during the dry season, whereas farm activities take place during the rest of the year. In addition, large differences exist in terms of labor input in staple and cash cropping. Women, for example, control cash-cropping activities, in which male labor is not used. Based on the above argumentation, as well as on the theory that production frontier estimation methods tend to be sensitive to outliers and that analysis of production efficiency should be restricted to relative homogeneous production technologies (Ali and Byerlee 1991), we propose to estimate efficiency separately for cereals.

To measure production efficiency, both input- and output-based efficiency measures have been used. Although the two approaches are equivalent under constant returns to scale, they differ under variable returns to scale. In the context of missing markets, it is likely that households are using fixed quantities (land, labor) of inputs to produce a maximum amount of output, which means an output-based efficiency measure, as also used by Chavas, Petrie, and Roth (2005) for households in rural Gambia, is appropriate. The production efficiency analysis includes as output variables kilograms of millet or sorghum harvested and as input variables land cultivated in hectare, costs of variable inputs in FCFA, dummies for tractor and plough use, and household labor input for males and females measured in days.

When we consider a household involved in staple cropping using inputs to produce a vector of outputs, as previously specified, the output-based technical efficiency (TE) index is defined as

$$TE(V, L, A, Q) = \min_{\theta} \{ \theta : (V, L, A; Q/\theta) \in X, \theta > 0 \}. \quad (2)$$



In general,  $0 \leq TE \leq 1$ , where  $TE = 1$  when the household is producing on the production frontier and is said to be technically efficient and where  $TE < 1$  when the farm is not technically efficient.

Data envelopment analysis (DEA) can be used to compute efficiency scores. DEA involves the use of linear programming methods to construct a nonparametric piecewise frontier over the data in order to calculate efficiencies relative to this surface, along the lines suggested by Farrell in 1957 (as cited in Coelli 1996). Given that many households are not perfectly competitive, the assumption of constant returns to scale (CRS) is often not appropriate. Banker, Charnes, and Cooper (1984) suggest an extension of the CRS DEA model to account for variable returns to scale (VRS) situations; theirs is the approach used here.

Possible sources of inefficiency can be grouped into factors that relate to managerial ability, endowment of physical capital, and financial market access. Managerial ability is thought to be explained by experience (age of the head of household); human capital (education level of household head and number of adults with primary or secondary education); relative endowment of physical capital, which depends on the ratio of adult females to males and of children to adults; and the number of continental or intercontinental migrants. The ratio of female to male adults and the dependency ratio reflect possible restrictions on labor allocation among household members. Endowment of physical capital is also described by the quality of productive assets and the number of cattle. Finally, financial market access (i.e., insurance and credit) can partly be explained by the number of continental or intercontinental migrants functioning as a proxy for remittances. Information on some other variables of interest was not available. In particular, the availability and use of extension services was not included in the survey information; therefore, the effect of the extension of technical efficiency cannot be tested here.

To address issues of sources of inefficiency among households, the TE scores obtained from equation (2) are regressed on a set of explanatory variables given in Table 4. Because all the efficiency indices have 1 as an upper bound and 0 as a lower bound, a Tobit model is estimated by maximum likelihood (Bravo-Ureta and Pinheiro 1997; Coelli, Rahman, and Thirtle 2002).

**Table 4. Explanatory variables for Tobit regression**

Variables	Nonmigrant (N = 38)	t-test means <sup>a</sup>	Continental migrant (N = 35)	t-test means <sup>b</sup>	Intercontinental migrant (N = 30)
Age of household head	47.97 (13.21) <sup>c</sup>	-0.99	51.20 (14.74)	-3.26	57.43 (9.93)
Education of household head (in years)	0.53 (1.84)	0.25	0.43 (1.48)	-0.62	0.93 (3.47)
Adults with primary education	0.55 (0.92)	0.05	0.54 (0.70)	-2.07	1.13 (1.38)
Adults with secondary education	0.21 (0.91)	-0.10	0.23 (0.11)	0.44	0.13 (0.35)
Adult female-to-male ratio (dummy)	0.32 (0.47)	0.75	0.24 (0.43)	2.79	0.07 (0.25)
Children-to-adult ratio	0.83 (0.57)	-0.09	0.85 (0.57)	-0.04	0.84 (0.47)
Cattle (number)	1.08 (1.50)	-1.51	1.69 (1.94)	-4.68	4.90 (4.31)
Value of farm equipment (in FCFA) <sup>d</sup>	20,878 (57,452)	-1.13	36,529 (60,162)	-3.34	75,893 (73,806)
Stock of migrants, lagged	-		1.03 (0.66)		1.70 (1.11)

Notes: Migrants not included. <sup>a</sup>Nonmigrant versus continental migrant households. <sup>b</sup>Nonmigrant versus intercontinental migrant households. <sup>c</sup> Standard deviation in parentheses. <sup>d</sup> 168 FCFA = \$1 (PPP 2002) (World Bank 2005)

Age of the household head is significantly higher for households with intercontinental migrants. Age represents a variety of features that are likely to influence the family business. First, the age of an actor provides a useful indicator of any cohort effects associated with socialization and internalization of broader societal worldviews. Second, age reflects the level of experience of the farm operator. Third, age can influence the farmer's physical ability to manage particular enterprises on the farm, thereby influencing management decisions. Finally, age can be taken to represent the stage of family development (Burton 2006).

Households with intercontinental migrants also have significantly more adults with primary education. In terms of endowment of physical capital, a dummy is included that takes the value of 1 when the number of adult males and females in the household is equal and 0 otherwise. For households with intercontinental migrants that have more females than males per hectare (see Table 2), the dummy for the male-to-female ratio is significantly smaller, suggesting unbalanced availability of household labor. Households with intercontinental migrants also have significantly more cattle and more valuable farm equipment as compared with households without migrants and with continental migrants.

The explanatory variables for migration need to be further specified. Migration represents an endogenous activity choice. However, most migrants in the surveyed households left some time in the past, typically several years before the survey. It is therefore possible to consider the number of past migrants as a predetermined "migration capital stock" variable (Taylor and Yunez-Naude 2000; Wouterse and Taylor 2008). We used the migration capital stocks, or the number of household members at each migrant destination, prior to the survey year to measure continental and intercontinental migration in the econometric model.

## 5. RESULTS

Applying the methodology discussed, estimates of technical efficiency were obtained for each household. Averages are presented by household migration status in the bottom panel of Table 5, which shows that the mean technical efficiency estimate measures range from 0.68 to 0.78. The significantly higher technical efficiency found for continental migrant households is comparable to the findings of Mochebelele and Winter-Nelson (2000) for staple crop production in Lesotho.<sup>8</sup> Technical efficiency of households with intercontinental migrants is significantly lower than the average.<sup>9</sup>

Overall, the results reported in Table 5 suggest that substantial shortfalls in cereal production efficiency exist. As mentioned, possible sources of inefficiency relate to managerial ability, endowments of human and physical capital, and access to financial capital.

**Table 5. Tobit analysis of technical efficiency**

Variables	Technical efficiency (N = 101)
Intercept	0.57 (0.17)** <sup>a</sup>
Age of household head	0.005 (0.003)*
Education of household head (in years)	0.06 (0.03)**
Adults with primary education	-0.14 (0.05)**
Adults with secondary education	-0.05 (0.07)
Adult female-to-male ratio (dummy)	0.24 (0.10)**
Children-to-adult ratio	-0.05 (0.07)
Cattle (number)	-0.007 (0.02)
Log value of farm equipment (FCFA)	-0.002 (0.007)
Stock of continental migrants, lagged	0.07 (0.04)*
Stock of intercontinental migrants, lagged	-0.05 (0.03)*
Pseudo R <sup>2</sup>	0.20
Prob>F	0.00
<hr/>	
Technical efficiency	
Nonmigrant	0.68
Continental migrant	0.78
Intercontinental migrant	0.61
Average	0.69

Notes: <sup>a</sup> robust standard errors in parentheses  
 \* denotes significance at 10% level  
 \*\* denotes significance at 5% level

<sup>8</sup> T-statistic of test between technical efficiency of continental migrant households and average efficiency is 2.18.

<sup>9</sup> T-statistic of test between technical efficiency of intercontinental migrant households and average efficiency is -1.62

To identify sources of inefficiency, the technical efficiency index for variable returns to scale, as given in Table 5, is regressed on a set of explanatory variables given in Table 4. The estimation results of the Tobit analysis for technical efficiency, reported in the top panel of Table 5, clearly illustrate the positive role of the age of the household head in production efficiency. Studies that include the age of the household head to explain technical efficiency have produced mixed and even contradictory results (Burton 2006). For example, older household heads, though more experienced, tend to be less physically fit, less likely to have contacts with extension agents, and less willing to adopt new practices and modern inputs (Bravo-Ureta and Pinheiro 1997). The result here, using the age of the household head, shows that experience is an important factor contributing to technical efficiency, perhaps because of expected acquisition of dexterity in doing the same task over a period of time (Okike et al. 2004).

The level of education of the household head also has a positive effect on efficiency. Weir (1999) for Ethiopia and Bravo-Ureta and Pinheiro (1993) for the Dominican Republic uncover a similar positive role for education in efficiency. The negative coefficient on the number of adults with primary education could suggest that those who spend more years in school will have spent less time in the fields learning traditional farm methods from the household head and may have developed negative attitudes toward farm labor (Weir 1999).

In terms of the endowment of physical capital, significance of the dummy for the adult female-to-male ratio indicates that a skewed gender distribution has a negative impact on efficiency. In cultivating cereals, specific tasks are traditionally allocated to males and to females, with the latter largely responsible for crop maintenance (weeding) and the former more involved in tasks such as plowing and transport (Quisumbing 1996). Such a task division along gender lines suggests that male labor and female labor are complementary. Although male tasks tend to be more easily substitutable (for example, farm animal input can be used in plowing), it is not surprising that a sufficiently large gender imbalance contributes to inefficiency.

An interesting contrast is uncovered in the way migration affects household efficiency in cereal production. There is a positive relationship between continental migration and technical efficiency. In contrast, intercontinental migration is associated with lower efficiency. Missing or incomplete markets, particularly for labor, credit, and insurance, create the possibility of asymmetric impacts of migration and remittances on efficiency across the asset distribution. To analyze the relationship between migration and technical efficiency in more detail, migration interactions with household assets were added. The estimated effects of these interactions, together with the new estimated direct migration effects when these interactions are included, are reported in Table 6.

The interaction effect of intercontinental migrants with farm equipment (Table 6, panel I) is positive, whereas the direct migration effect remains negative and significant. This result indicates that although intercontinental migration, through its effect on farm equipment, affects technical efficiency positively, this does not compensate for the negative direct effect. A similar result holds for cattle (Table 6, panel II). Intercontinental migration, through its effect on cattle accumulation, positively affects efficiency. Higher livestock ownership reduces inefficiency through crop-livestock interactions, such as manure availability and better use of residues (Okike et al. 2004). Once again, however, the direct effect of intercontinental migration on efficiency remains negative. Finally, the interaction of intercontinental migration with the dummy for the female-to-male labor ratio (Table 6, panel III) is strongly negative and significant, whereas the direct migration effect becomes insignificant. For continental migrant households, none of the interactions is significant, suggesting that these households, by sending out migrants, relieve themselves of excess male labor, redressing the gender imbalance and thereby improving efficiency.

The findings from our model with asset-migration interactions suggest that although asset-rich intercontinental migrant households could improve technical efficiency in cereal cropping through investment in farm equipment and cattle, the pronounced imbalance between males and females in labor input has a strong negative effect on inefficiency. In intercontinental migrant households, women spend more time, as compared with men, on all agricultural tasks. Lower efficiency of women in agriculture in Burkina Faso has also been found by Bindlish, Evenson, and Gbetibouo (1993) and by Udry et al. (1995).

In addition to a breakdown of complementary relationship of male and female labor due to migration, another possible explanation for women's lower efficiency is the more limited access of female farmers to extension, perhaps due to its male orientation (Moock 1976). However, because of lack of data on extension services, this theory cannot be tested here. Finally, in addition to a pure migration effect of reduced availability of male labor, effort itself may be reduced in intercontinental migrant households due to the financial support of migrants, which makes the balance between production and cereal needs less essential, creating a disincentive effect on productive behavior (Gubert 2002).

**Table 6. Migrant-asset interaction effects on technical efficiency**

	<b>Technical efficiency</b>
<b>I. Interaction: farm equipment</b>	
Equipment x continental migrants	0.001 (0.007) <sup>a</sup>
Equipment x intercontinental migrants	0.10 (0.005)*
Equipment	-0.008 (0.01)
Continental migrants	0.07 (0.06)
Intercontinental migrants	-0.10 (0.04)**
<b>II. Interaction: cattle</b>	
Cattle x continental migrants	-0.004 (0.01)
Cattle x intercontinental migrants	0.03 (0.01)**
Cattle	-0.03 (0.03)
Continental migrants	0.08 (0.04)*
Intercontinental migrants	-0.17 (0.06)**
<b>III. Interaction: Female-to-male ratio dummy</b>	
Female-to-male dummy x continental migrants	-0.04 (0.13)
Female-to-male dummy x intercontinental	-0.42 (0.16)**
Female-to-male ratio dummy	0.32 (0.11)**
Continental migrants	0.08 (0.04)*
Intercontinental migrants	-0.04 (0.03)

Notes: <sup>a</sup> robust standard errors in parentheses

\* denotes significance at 10% level

\*\* denotes significance at 5% level

Combining the different interaction effects explains why intercontinental migration, which provides the household with access to substantial amounts of finance, does not lead to an intensification of cereal production. Although this form of migration is related to more investment in farm equipment and cattle, a missing market for labor appears to hamper the transformation of cereal production practices from traditional to modern. As mentioned, differences in labor input during crop maintenance point toward flexibility in production. In traditional rain-fed agriculture, such flexibility allows farm households to deal with exogenous shocks. In the context of a missing market for labor, however, households are aware that overly ambitious production plans are likely to lead to seasonal manpower constraints that are more severe due to the loss of male labor to migration (Fafchamps 1993).

## 6. CONCLUSIONS AND DISCUSSION

When markets are incomplete or missing, migration is likely to have an impact on the production of cereals. This paper analyzes the consequences of continental and intercontinental migration for the production of millet and sorghum. Millet and sorghum production is characterized as traditional, with little use of external inputs and with households relying heavily on labor input. A missing market for labor implies that labor lost to migration cannot be replaced by hired labor; thus, the consequences of migration may be severe. Both continental and intercontinental migration represent a loss of labor to the household. But they also both represent a gain in the form of remittances, which is much more substantial for households with intercontinental migration.

Empirical evidence from an economic analysis of farm household production efficiency suggests that the destination of migrants is an important explanatory factor in inefficiency. Continental migration is associated with improved efficiency by shifting labor time of male adults away from cereal production. The negative relation between intercontinental migration and efficiency is explained by a distortion of the gender balance in the household, with females becoming the prominent provider of labor in cereals.

The ability of households to adopt cereal production to changing factor endowments implies that migrant households remain involved in staple cropping. At the same time, however, cereal production practices are not transformed from traditional to modern. A missing market environment forces households to allow for flexibility in their production practices and to make investments in traction equipment—not to increase productivity, but to retain flexibility. Even though intercontinental migration, in particular, increases household access to finance, a missing market for labor does not allow for ambitious production plans, which are only likely to lead to seasonal manpower constraints.

Migration and remittances have development implications that are most relevant for policymakers. A benchmark for development that is useful in the current context is how migration and related remittances reshape migrant-sending economies. As demonstrated in this paper, even though intercontinental migration provides households with the required liquidity, productive investments in agriculture are not made. This finding demonstrates that if migrants leave in response to a lack of productive investment opportunities in the local economy, then remittances alone will not suffice to transform agricultural production. Productive investments are strongly related to the level of market formation and local economy conditions. Thus, to maximize benefits of migration, imperfections in the market environment will still need to be addressed.

## REFERENCES

- Adams, R. H. 1998. Remittances, investment, and rural asset accumulation in Pakistan. *Economic Development and Cultural Change* 47(1): 155–173.
- Adepoju, A. 1997. Migration and development in tropical Africa: Some research priorities. *African Affairs* 76(303): 210–225.
- Aigner, D., C. Lovell, and P. Schmidt. 1977. Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6(1): 21–37.
- Ali, M., and D. Byerlee. 1991. Economic efficiency of small farmers in a changing world: A survey of recent evidence. *Journal of International Development* 3: 1–27.
- Arthur, J. A. 1991. International labor migration patterns in West Africa. *African Studies Review* 34(3): 65–87.
- Banker, R. D., A. Charnes, and W. W. Cooper. 1984. Some models for estimating technical and scale efficiency in data envelopment analysis. *Management Science* 30: 1078–1093.
- Bindlish, V., R. Evenson, and M. Gbetibouo. 1993. Evaluation of T&V-based extension in Burkina Faso. World Bank Technical Paper 226. Washington, DC: World Bank.
- Black, R. 1993. Migration, return and agricultural development in Serra de Alvao, northern Portugal. *Economic Development and Cultural Change* 41: 563–585.
- Bravo-Ureta, B. E., and A. E. Pinheiro. 1997. Technical, economic and allocative efficiency in peasant farming: Evidence from the Dominican Republic. *The Developing Economies* 35(1): 48–67.
- Burton, R. 2006. An alternative to farmer age as an indicator of life-cycle stage: The case for a farm family age index. *Journal of Rural Studies* 22: 485–492.
- Chavas, J. P., R. Petrie, and M. Roth. 2005. Farm household production efficiency: Evidence from the Gambia. *American Journal of Agricultural Economics* 87(1): 160–179.
- Coelli, T. J. 1996. *A guide to DEAP version 2.1: A data envelopment analysis (computer) program*. CEPA Working Papers 8/96. Armidale, Australia: University of New England
- Coelli, T. J., S. Rahman, and C. Thirtle. 2002. Technical, allocative, cost and scale efficiencies in Bangladesh rice cultivation: A nonparametric approach. *Journal of Agricultural Economics* 53(3): 607–626.
- David, R. 1995. *Changing Places: Women, Resource Management and Migration in the Sahel*. London: SOS Sahel.
- Fafchamps, M. 1993. Sequential labor decisions under uncertainty: An estimable household model of West African farmers. *Econometrica* 61(5): 1173–1197.
- Findley, S. E. 1987. Migration and family interactions in Africa. In *Family, Population and Development in Africa*, ed. A. Adepoju. London: Zed Books.
- Gubert, F. 2002. Do migrants insure those who stay behind? Evidence from the Kayes Area (Western Mali). *Oxford Development Studies* 30(3): 267–287.
- Hyden, G., R. W. Kates, and B. L. I. Turner. 1993. Beyond intensification. In *Population Growth and Agricultural Change in Africa*, ed. B. L. I. Turner, G. Hyden, and R. W. Kates. Gainesville: University of Florida Press.
- Jokisch, B. D. 2002. Migration and agricultural change: The case of smallholder agriculture in highland Ecuador. *Human Ecology* 30(4): 523–550.
- Kessler, J. J., and C. Geerling. 1994. *Profil Environnemental du Burkina Faso*. Wageningen, The Netherlands: Wageningen University.
- Kuiper, M. 2005. *Village Modeling: A Chinese Recipe for Blending General Equilibrium and Household Model*. Unpublished Ph.D. thesis, Wageningen, The Netherlands: Wageningen University.
- Lanjouw, P., J. Quiznon, and R. Sparrow. 2001. nonagricultural earnings in peri-urban areas of Tanzania: Evidence from household survey data. *Food Policy* 26: 385–403.

- Low, A. 1986. *Agricultural Development in Southern Africa: Farm Household Economics and the Food Crisis*. London: James Currey.
- Mazzucato, V., and D. Niemeijer. 2000. *Rethinking Soil and Water Conservation in a Changing Society: A Case Study in Eastern Burkina Faso*. Unpublished Ph.D. thesis. Wageningen, The Netherlands: Wageningen University.
- Mines, R., and A. de Janvry. 1982. Migration to the United States and Mexican rural development: A case study. *American Journal of Agricultural Economics* 64: 444–454.
- Mochebelele, M. T., and A. Winter-Nelson. 1999. Migrant labor and farm technical efficiency in Lesotho. *World Development* 28(1): 143–153.
- Moock, P. 1976. The efficiency of women as farm managers: Kenya. *American Journal of Agricultural Economics* 58(5): 831–835.
- Okike, I., M. Jabbar, V. Manyong, J. Smith, and S. Ehui. 2004. Factors affecting farm-specific production efficiency in the Savanna zones of West Africa. *Journal of African Economies* 13(1): 134–165.
- Ouedraogo, R. S., J. P. Savodogo, V. Stamm, and T. Thiombiano. 1996. Tenure, agricultural practices and land productivity in Burkina Faso: Some recent empirical results. *Land Use Policy* 13(3): 229–232.
- Palmer, I. 1985. *The Impact of Male Out-Migration on Women in Farming*. West Hartford, CT: Kumarian Press.
- Pingali, P., Y. Bigot, and H. P. Binswanger. 1989. *Agricultural Mechanization and the Evolution of Farming Systems in Sub-Saharan Africa*. Washington, DC: World Bank.
- Quisumbing, A. R. 1996. Male-female differences in agricultural productivity: methodological issues and empirical evidence. *World Development* 24(10): 1579–1595.
- Stark, O. 1991. *The Migration of Labour*. Cambridge, UK: Basil Blackwell.
- Taylor, J. E., and P. L. Fletcher. 2007. Remittances and development in Mexico: Part one: The new labor economics of migration: A critical review. In *Rural Mexico Research Review*, ed. P. L. Fletcher. Davis: University of California.
- Taylor, J. E., and A. Yunez-Naude. 2000. The returns from schooling in a diversified rural economy. *American Journal of Agricultural Economics* 82: 287–297.
- Udry, C., J. Hoddinott, H. Alderman, and L. Haddad. 1995. Gender differentials in farm productivity: Implications for household efficiency and agricultural policy. *Food Policy* 20(5): 407–423.
- Weir, S. 1999. The effects of education on farmer productivity in rural Ethiopia. Working Paper Series 91. Oxford, UK: Centre for the Study of African Economies
- World Bank. 2005. *World Development Indicators*. Retrieved from <http://devdata.worldbank.org/wdi2005/Section2.htm>.
- Wouterse, F., and J. Taylor. 2008. Migration and income diversification: Evidence from Burkina Faso. *World Development* 36(4): 625–640.
- Yusuf, S. 2003. Globalisation and the Challenge for Developing Countries. *Journal of African Economies* 12 (AERC suppl. 1): 35–72







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