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**A Hedonic Analysis of Cattle Prices in the Central Corridor of West Africa:  
Implications for Production and Marketing Decisions<sup>1</sup>**

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## **A Hedonic Analysis of Cattle Prices in the Central Corridor of West Africa: Implications for Production and Marketing Decisions**

### **Abstract**

Detailed weekly sales transactions data for the period January 2000-June 2001 from three frontier markets in the central corridor of West Africa were analyzed to identify the factors influencing short-run, intra-year cattle prices. The empirical results indicate that in addition to market location and seasonality of supply and sales, market participants show systemic preferences for specific cattle attributes (sex, weight, condition and finish) and are willing to pay premium prices consistent with their preferences. Communicating this information to producers can assist them to tailor their production and marketing decisions to meet market expectations and thereby improve their competitiveness, profitability and intra-regional livestock trade. Innovative policy and institutional approaches to improve market information dissemination and ease other constraints that tend to dampen supply response, even in the face of favorable prices, are discussed in the paper.

**JEL subject codes:** C21, D4, Q13, Q17

**Key words:** livestock markets, hedonic price model, market information, West Africa

### **Introduction**

In the central corridor of West Africa, livestock markets and trade have historically linked the Sahelian countries (Burkina Faso, Mali, Niger) in the semi-arid zone with coastal countries (Côte d'Ivoire, Ghana and Nigeria) in the humid zone. The biophysical environment in the Sahel which favors livestock production enables countries in this zone to produce surplus animals which are exported to the coastal countries. The

long-standing nature of this trade coupled with missing markets in market information have lured producers to rely on traditional production and marketing practices. Yet, the market and policy reforms that have been widely implemented in the region, high human population growth rate (at 2.7% per year between 1980-2001 and projected at 2% per year over the next 10 years (World Bank, 2003)) and rapid urbanization (estimated at 4.3% per year (authors' estimates based on UN (2005))) may have altered long-established patterns in terms of characteristics of products demanded, periods of demand, factors affecting short-run cattle prices and price differentials across cattle types. Failure to communicate such changes in market expectations to producers, if indeed they are occurring, can result in failure to alter production and marketing decisions to increase profitability, meet consumer expectations and improve intra-regional trade.

The objective of this paper is to identify the market factors influencing short-run cattle prices in the central corridor of West Africa. An additional objective is to determine if market participants in this region have systemic preferences for cattle attributes and whether they are willing to pay price premiums or discounts for these attributes consistent with their preferences.

The paper begins with a brief description and review of livestock markets in the central corridor. The study area and research methods are described followed by presentation of the results. The paper concludes with some insights into how the results generated can be used to guide producers' management and marketing decisions.

### **Livestock Markets and Marketing Channels in the Central Corridor**

Smallholder producers who sell their animals to itinerant traders at the farm gate are at the apex of the livestock marketing channel. **Collection markets** - centrally located

rural markets that serve large groups of villages – are occasionally used by small-scale producers to sell animals and to purchase breeding, fattening and draft animals (Figure 1). Itinerant traders also use them to sell to export traders or make additional purchases for disposal at secondary (frontier) markets. **Frontier markets** – markets that are strategically located along the border of neighboring countries to ease cross-border trade – provide a location for regrouping animals purchased upstream destined for export, but non-export transactions also take place in these markets. Domestic livestock marketing ends at this point, while the cross-border segment extends to the **terminal markets** in Côte d’Ivoire, Ghana and Nigeria.

These markets have been studied in a number of different ways. Studies that have addressed the microeconomic behavior of market participants, such as individual traders, (Ariza-Nino et al., 1980; Delgado and Staatz, 1980; Holtzman and Kulibaba, 1994) have highlighted the importance of transaction costs facing these economic agents, the role of intermediaries in reducing transaction risks and the complex set of relationships and social capital that underlie livestock value chains. A number of studies, using secondary livestock price and volume data, have identified the long-run determinants of livestock prices and investigated seasonal price trends (Hesse, 1987; Ly, 1990; Fafchamps and Gavian, 1997). These studies and others (Williams, 1993) have demonstrated the effects of weather shocks, shifts in rural and urban demand for meat and national trade policies on livestock prices and sales volumes. Fafchamps and Gavian (1996) investigated the spatial integration of livestock markets in Niger and provided evidence of market segmentation and lack of price transmission either in the short- or long-run. Turner and Williams (2002) examined the factors influencing prices received by livestock producers at the level of primary markets in rural villages and found that price formation is socially

biased by gender, wealth and location reflecting differential access and powers within local markets.

Very few studies have investigated how the interplay of product attributes, buyer preferences and the opportunity of cross-border trade can influence price determination in frontier markets despite the strategic importance of such markets and the insights that can be gained into how product offerings and intra-regional trade could be better managed to improve the welfare of market participants. This paper fills this gap by analyzing the product characteristics and market factors that impact livestock prices in 3 frontier markets located in two countries in the central corridor of West Africa. The comparative analysis of these markets adds a rich dimension to the literature on livestock marketing and price formation in the region.

### **Study Area**

Three frontier markets located at Sikasso in southern Mali, Niangoloko in southern Burkina Faso and Bittou in eastern Burkina Faso were selected as the main sites of investigation for this study (see Figure 2). The Sikasso market is located about 100 km from the Malian border with Côte d'Ivoire and handles cattle destined for export, local slaughter and other uses on a daily basis. The Niangoloko market is located right at the border between Burkina Faso and Côte d'Ivoire and operates mainly on Saturdays, although animals may be brought to the market for sale and resale any day of the week. The Bittou livestock market is at the border between Burkina Faso, Ghana and Togo and is open every third day for livestock transactions.

## **Research Methods**

### **a) Data Collection**

Preliminary investigation to establish sampling frames, profiles of market participants (i.e. sellers, buyers and market agents) and major features of each market started in June 1999, but regular market surveys on a weekly basis commenced in December 1999 and ended in June 2001. In addition to weekly market (transactions) surveys in each of the 3 frontier markets, traders in these markets were also surveyed using structured questionnaires. Data collected through the market transactions surveys included information on the geographic origin of the animal to be sold, price at the point of origin, mode and cost of transportation to the market, weight, sex, age, condition, breed, color, purpose of purchase (e.g. slaughter, fattening, draft power, export), type of seller (farmer, trader, livestock breeder), type of buyer (farmer, trader, butcher), arbitrage functions performed by different marketing agents, sale price at the frontier market, total number of animals presented for sale on a market day and number actually sold. Data collected on animal characteristics and intended uses of purchased animals made it possible to identify the impact of various cattle attributes on cattle prices depending on the type of demand. In all, 19,001 transactions involving 11,419 cattle, 3612 sheep and 3970 goats were recorded in the 3 frontier markets with the following specific breakdown: Sikasso (7404 cattle), Niangoloko (2230 cattle) and Bittou (1785 cattle, 3612 sheep and 3970 goats). Only a subset of the cattle transactions data were utilized in the analysis presented below.

### **b) Analytical method**

A hedonic price model was fitted to determine the factors influencing short-run cattle prices. A hedonic price function relates the price of a product to the various

attributes embodied in the commodity. The underlying hypothesis is that products have utility-bearing attributes and the values of those attributes contribute to the price of the product. In the marketplace, utility-maximizing buyers and sellers interact to establish the market value for a given attribute. The observed price of a good is therefore a composite of the implicit values of the product's attributes. Characteristics that are likely to influence the price of cattle include age, sex, color, breed, weight and body condition as well as quality attributes related to the intended use of the purchased animal (e.g. breeding, slaughter, fattening, traction and export).

For this analysis, a hedonic price model based on Analysis of Covariance (AnCov) (Gujarati, 1995) was fitted. The general implicit form of the AnCov may be written as:

$$P = F(Q, C) + U \quad (1)$$

where P is the observed price of the product, Q is a set of factors, C is a set of covariates, and U is a residual error term.

In order to eliminate day-to-day variation in the prices utilized in the empirical model, a number of price transformations were tried following Portugal and von Oppen (1999) who constructed a reference value based on the average price per survey interval, and Turner and Williams (2002) who equalized the residual variance through a log transformation of price. The log transformation provided a better fit, with the coefficients having signs that were consistent with theoretical expectations. Therefore, the empirical model estimated was specified as:



$$\ln(\text{price/kg}) = b_0 + b_1AGE + b_2AGE^2 + f_1SEX + f_2COND + f_3BRD + f_4POP + f_5SOS + f_6FM + f_7TOB + f_8TOS + e_i \quad (2)$$

where *AGE* = age of animal (in years), *SEX* = castrate, female, male; *COND* = body condition rating (very lean, lean, good, very good, excellent), *BRD* = breed, *POP* = purpose of purchase, *SOS* = season of sale (cool dry, hot dry, rainy, harvest), *FM* = market location, *TOB* = type of buyer, *TOS* = type of seller and  $\varepsilon_i$  is the error term (see also Table 2 for description of other variables not fully specified here).

In the empirical model, castrated zebu cattle in excellent body condition was used as the reference animal (base) for comparison of the effects of different attributes on cattle prices. The model was estimated using the AnCov procedures of SAS (Statistical Analysis System).

## Results

Table 1 provides descriptive statistics for cattle traded in the frontier markets. It shows that cattle were generally marketed at about 7 years of age weighing approximately 250kg. Cattle from Burkina Faso, i.e. Bittou and Niangoloko, were marketed at 5-6 years of age (i.e. 1-2 years earlier than in Sikasso, Mali). Since it is normal for cattle in this region to attain a liveweight of 250kg from about 4 years of age, the lower age at marketing in Bittou and Niangoloko suggests that off-take rate may be higher in Burkina Faso than in Mali. Sikasso is a bigger market than either Bittou or Niangoloko and this is seen in the average number of animals presented for sale each market day. A higher percentage of animals brought to the markets in Niangoloko and Bittou markets were sold compared to the situation in Sikasso.

Table 2 summarizes the results of the hedonic price model for cattle in each frontier market and for all markets combined. The models had R-squared values ranging from 0.208 for the Bittou market to 0.508 for Niangoloko market. The resulting coefficients had the expected signs and the F-statistics were highly significant for all the models. Taken together, these statistics suggest goodness of fit of the models, particularly in Niangoloko where about 51 per cent of the variability in cattle price per kg liveweight was explained by variables in the model.

The model results indicate that buyers are willing to pay a premium for well finished, castrated zebu cattle in excellent body condition. Cattle with lower body condition scores received significant discounts compared to the base group, implying a preference for animals in excellent body condition.

Female cattle attracted the lowest price in the combined model and in Niangoloko with no significant difference by sex in Bittou and Sikasso. In Sikasso, male cattle attracted significantly higher price per kg bodyweight compared with castrates. The lower price offered for female cattle is mainly because producers only sell female animals at the end of their productive life, which makes them older than bulls and castrates offered for sale. The coefficients for *age* and *age*<sup>2</sup> had positive and negative signs, respectively, meaning that after a certain age, the price offered for cattle declined. The age at which the price of cattle started to decline was econometrically determined as 8.8 years for Sikasso, 8.2 years for Niangoloko, and 8.0 years for Bittou. The practical implication of this is that farmers should endeavor to sell their cattle before they reach 8-9 years in the study region.

With respect to the purpose of purchase, cattle purchased for export was used as the base for comparison. Compared to prices offered for export cattle, those purchased for traction and slaughter attracted lower prices. This was clearly so in Niangoloko compared to the other markets. Although not statistically significant, animals purchased for fattening attracted lower prices and this is mainly because they are mostly growing, lean animals. The offer of a premium for export quality cattle is expected. Livestock producers will, therefore, benefit more if they target their finished animals at the export market just as traders/producers interested in fattening for resale should source their stock from the cheaper, lean to very lean animals (see also Table 3). Breeding cattle, mainly young and virile animals, are in a different class. They attracted significantly higher prices than export cattle because of the reproductive functions they are expected to perform to ensure herd growth and continuity.

In the empirical model, the cool dry season corresponds to January – March; hot dry season (April – June); rainy season (July – September) and the harvest season (October – December). The harvest season was used as the base for comparison of the effects of season of sale on prices. The results show that compared to the harvest season, the highest prices were obtained during the hot dry and rainy seasons, except in Sikasso where there was no clear pattern. Small and medium-scale farmers engaged in fattening schemes could take advantage of higher prices during these two seasons to bring their finished animals to the market at these periods. They could gain not only from the higher prices, but also from the premium that has been shown to be offered for export cattle in excellent body condition.

In sum, the model results indicate that animal age, sex, breed, body condition, purpose of purchase, season of sale and market location are the most significant factors influencing short-run cattle prices in the study region. The model also allowed comparison of prices offered for cattle at the different frontier markets. Cattle were cheapest in Niangoloko followed by Sikasso, and most expensive, on weight basis in Bittou. Possible reasons for the differences in prices include variations in the structure of the marketing channels and level of integration of frontier markets with primary and tertiary markets.

The results of the price formation models which indicated a premium for cattle in excellent body condition elicited further statistical analyses to determine prices paid per kg liveweight for the five different grades of cattle included in this study. As Table 3 shows, price per kg liveweight in all markets combined varied from US\$ 0.52 ( $\pm 0.18$ ) for very lean cattle to US\$ 0.75 ( $\pm 0.12$ ) for cattle in excellent body condition, with the widest range in prices occurring in Sikasso where very lean cattle only attracted US\$ 0.36 ( $\pm 0.06$ ) compared to US\$ 0.86 ( $\pm 0.18$ ) for cattle in excellent body condition. Similar patterns were found for Bittou and Niangoloko frontier markets and reinforce the existence of a premium for well finished animals.

## **Discussion and Conclusion**

The empirical results presented above indicate that producers will obtain higher prices if they sell castrated zebu cattle in excellent body condition. However, further analysis revealed that small-scale producers were not yet fully taking advantage of this opportunity as less than a fifth (i.e. only 14%) of the approximately 11,500 cattle traded

possessed the characteristics preferred by premium buyers. A significant proportion of the cattle sold (about 70%) were in the median range of 'good' to 'very good.'

Two possible reasons could be adduced for the inability of smallholders to capitalize on the favorable market conditions. First, information on market preferences or their associated potential profitability was not sufficiently transmitted back to producers and/or, secondly, there were other constraints (e.g. lack of feed, credit, communication networks, good rural road and transport infrastructure) that dampened supply response, even in the face of favorable prices.

There is evidence of the financial and economic profitability of cattle and sheep fattening in the region. Metzel et al. (1997) reviewed past trends in fattening programs in Mali and estimated benefit/cost ratios averaging 1.85 for large-scale fattening, and 4.08 and 4.52 for small-scale cattle and sheep fattening, respectively. Thus, it appears that efforts to finish animals properly through fattening before marketing will be well compensated. However, market information dissemination to rural small-scale producers is at best patchy or not very effective in the study region.

The policy implications are clear. Effective market information gathering and dissemination systems are needed to transmit market preferences to producers. An approach that was used as part of the market development component of the project reported here was to organize meetings with small-scale producers, through their local associations, to share the findings of this study with them. Furthermore, to ensure continuous exchange and transmission of market information, telephone lines were installed in the frontier markets and desktop computers purchased to process market information which the associations will periodically disseminate to their members. Other innovative approaches that take advantage of improvements in information and

communication technologies (e.g. solar-powered radios and TVs, mobile telephones, village telephone centers and internet cafés, wireless services etc) will ensure that market information is quickly and completely transmitted to producers. Policy interventions to make credit available to small-scale producers for fattening operations and improvements in rural physical infrastructure and transport systems will enhance their access to markets and ensure rapid response to new market opportunities. These measures apart from enhancing smallholders' competitiveness will also enable them to earn higher prices and will ultimately contribute to poverty alleviation as this group constitutes the most numerous but poorest livestock producers in the region.

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**Table 1: Descriptive statistics for cattle traded at the Niangoloko, Bittou and Sikasso frontier markets, January 2000 – June 2001**

Parameter	Market							
	Niangoloko ( $n = 1940$ )		Bittou ( $n = 839$ )		Sikasso ( $n = 959$ )		All markets ( $n = 3738$ )	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Age of cattle (years)	5.6	2.6	5.0	1.7	7.7	1.9	6.9	2.3
Weight (kg)	253.2	61.2	250.3	83.5	256.4	56.3	253.3	65.7
Number presented* (head)	17.3	10.9	80.2	29.4	113.8	32.5	73.6	49.6
Number sold* (head)	15.3	10.0	53.8	26.5	38.7	10.5	34.3	21.6
Percentage sold (%)	87.9	13.4	65.7	18.5	35.6	11.3	60.5	26.8
Price at initial market of purchase (US\$/kg liveweight)	0.57	0.13	0.68	0.14	0.63	0.17	0.59	0.14
Price at frontier market (US\$/kg liveweight)	0.63	0.13	0.71	0.15	0.69	0.25	0.66	0.18

Source: Survey data

\* Number presented = Average number of cattle presented for sale on a typical market day

\* Number sold = Average number of cattle sold out of those presented on a typical market day



**Table 2: Estimated coefficients and t-ratios of hedonic price models for cattle in Niangoloko, Bittou and Sikasso livestock markets, January 2000 – June 2001.**

Parameter	ALL		NIANGOLOKO		BITTOU		SIKASSO	
	<i>n</i> = 3738		<i>n</i> = 1940		<i>n</i> = 839		<i>n</i> = 959	
	B	t	B	t	B	t	B	t
Intercept	618.70***	90.69	609.30***	89.67	589.50***	38.81	575.70***	33.20
Age	1.27**	2.29	1.32**	2.09	4.12***	3.20	3.07**	2.22
Age-squared	-0.16***	-4.22	-1.46***	-3.44	-0.39***	-3.97	-2.53***	-2.83
<b>Biological characteristics</b>								
<i>SEX</i>								
Female	-6.02***	-5.54	-10.50***	-7.79	-3.96	-0.85	-2.78	-1.42
Male	-0.81	-0.76	-1.739	-1.41	-2.65	-0.61	4.33**	1.86
Castrate	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<i>CONDITION SCORE</i>								
Very lean	-39.80***	-12.11	-13.70*	-1.76	-22.90***	-4.22	-80.90***	-10.26
Lean	-28.00***	-18.54	-24.10***	-12.19	-17.50***	-4.56	-40.00***	-10.06
Good	-17.20***	-14.37	-16.00***	-12.86	-10.20***	-2.95	-22.80***	-6.27
Very good	-8.02***	-7.21	-7.84***	-7.10	-3.46	-1.02	-7.05**	-2.07
Excellent	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<i>BREED</i>								
Dgog	2.59	1.62	-19.00***	7.79	-	-	-	-
Mery	-7.24***	-3.66	-27.446	-1.27	-	-	-	-
Meti	-4.65***	-3.68	-25.90***	-2.99	-19.10***	-3.72	-2.08	-1.35
Ndama	-4.18	-1.11	-	-	-	-	-2.57	-0.58
Zebu	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<b>Marketing factors</b>								
<i>PURPOSE OF PURCHASE</i>								
Slaughtering	-10.20	-1.59	-16.10**	-2.43	-10.10	-0.59	-	-
Fattening	-3.45	-0.83	-4.104	-0.83	-1.01	-0.14	-	-
Traction	-11.9*	-1.89	-17.8***	-2.98	2.83	0.20	-	-
Breeding	7.47*	1.82	9.43**	2.37	-1.76	-0.20	-	-
Reselling	4.53	0.53	3.07***	3.36	0.96	0.53	-32.80***	-3.21
Export	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<i>TYPE OF SELLER</i>								
Trader	5.94	0.37	-4.72*	-1.70	-0.60	-0.22	1.92	0.44
Breeder	0.59	0.39	136.300	0.76	-4.11	-1.48	5.85	1.18
Others	3.85	0.77	19.80***	3.08	-	-	-3.69	-0.44
Farmer	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<i>TYPE OF BUYER</i>								
Trader	-11.20*	-1.83	-24.10***	-3.96	4.64	0.33	28.70*	1.79
Breeder	0.92	0.16	-19.6***	-3.06	14.70	1.15	92.90***	4.95
Butcher	-0.82	-1.42	-20.8***	-3.64	16.30	0.87	27.00*	1.70
Others	-5.88	-1.04	-17.40***	-3.32	-	-	29.40	1.58
Farmer	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a
<i>SEASON</i>								
Cool dry	3.094***	2.92	-2.15**	-1.97	4.75**	2.14	0.76	0.40
Hot dry	11.10***	10.88	12.90***	13.19	11.30**	4.81	-2.24	-1.20
Rainy	10.20***	9.40	12.30***	11.17	9.01***	3.48	(0)a	(0)a
Harvest	(0)a	(0)a	(0)a	(0)a	(0)a	(0)a	-	-
<i>FRONTIER MARKET</i>								
Niangoloko	-16.50***	-9.64	-	-	-	-	-	-
Bittou	-6.505**	-2.01	-	-	-	-	-	-
Sikasso	(0)a	(0)a	-	-	-	-	-	-
R-squared	0.364		0.508		0.208		0.357	
F-Statistic	46.439***		65.938***		9.708***		42.456***	

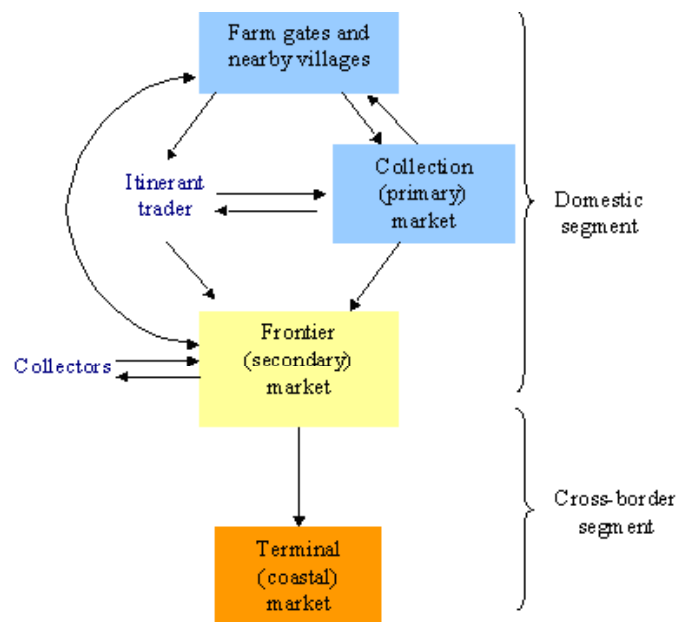
\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ; – variable not included in the model; (0)a denotes base variable

**Table 3: Average prices (US\$/kg liveweight) paid by cattle traders for the five grades of cattle presented for sale at the 3 frontier markets**

Market		Body condition score					
		Very lean	Lean	Good	Very Good	Excellent	All cattle
Niangoloko	Price/kg liveweight (US\$)	0.49	0.48	0.59	0.65	0.73	0.63
	Std. deviation	0.11	0.14	0.11	0.13	0.11	0.13
	% of cattle in category	0.3	5.3	46.9	25.6	21.9	100
Bittou	Price/kg liveweight (US\$)	0.59	0.65	0.70	0.76	0.78	0.71
	Std. deviation	0.18	0.17	0.15	0.13	0.12	0.16
	% of cattle in category	2.9	17.7	42.1	32.2	5.0	100
Sikasso	Price/kg liveweight (US\$)	0.36	0.55	0.67	0.79	0.86	0.69
	Std. deviation	0.06	0.12	0.30	0.16	0.18	0.25
	% of cattle in category	1.0	18.0	49.9	24.5	6.6	100
All markets	Price/kg liveweight (US\$)	0.52	0.57	0.63	0.72	0.75	0.66
	Std. deviation	0.18	0.16	0.20	0.15	0.12	0.18
	% of cattle in category	1.0	11.5	46.6	26.8	14.1	100

**Source: Survey data**

**Figure 1: Livestock marketing channels in the central corridor of West Africa**



**Figure 2: Map showing countries of the central corridor of West Africa and locations of the frontier markets in Sikasso (Mali) and Niangoloko and Bittou (Burkina Faso)**

