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The Changing Economic Context of Mixed Farming in Savanna West Africa: A Conceptual Framework Applied to Burkina Faso*

Christopher L. Delgado**

1. Introduction

Mixed farming, in the narrow sense of the keeping of cattle on smallholder crop farms, has been a major theme of agricultural development policy in the tse-tse free parts of West Africa since colonial times. Yet adoption of oxen draft cultivation, smallholder dairying, and feeding-for-meat practices are not widespread in the region (Boudet, 1969; Delgado, 1979a; Jahnke, 1982). The main economic issue in mixed farming in West Africa is the evolution of the opportunity cost of resources used in various activities, a notion that can only be adequately introduced by looking at the whole farm/household and its relationship to incentives structures that surround it. It will be argued that the desirability of mixed farming in the West African Savanna depends upon both the local need for technologies to increase labor input per unit of land and upon the feasibility of such intensification in the overall system of incentives facing farmers. Furthermore, it will be argued that current trends tend both to favor animal traction relative to other mixed farming activities involving cattle and to favor mixed farming relative to non-farming investment. The case will be illustrated with data pertaining to Burkina Faso.

Strictly speaking, the opportunity costs of resources are the highest returns that these resources could secure in any use, given the absence of factor market or output price distortions. However, such distortions abound in most of Africa, and Burkina Faso is no exception. The analysis of "socially optimal" policies is therefore exceedingly complex. As a practical matter, what follows concerns opportunity costs seen through the eyes of the farmer, or what the farmer could have made from the most profitable use of resources. This simplification is somewhat justified by its usefulness in matters of technology adoption. Furthermore, farmers' perceptions of factor opportunity costs are not limited to agricultural options. Research in the West African savanna generally, and in Burkina Faso in particular, has shown that farmers typically obtain from 25 to 50% of their total income from non-agricultural production (Newman et al., 1979; Readon et al., 1988).

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2. Farm Resources and Options

The typical smallholder in Burkina Faso – and perhaps in much of savanna West Africa – cultivates on the order of three to four hectares of land, with approximately four active workers. Millet and sorghum are the basic staples, with maize production rapidly growing from a small base in the southwest. Cash crops include cotton on suitable soils, and peanuts. Much of cropped area is outside the tse-tse belt, and thus is suitable for cattle raising. A large percentage of the adult male labor force is absent from the farm, having migrated to the city, or farther south to Côte d'Ivoire (Delgado, 1979a; Newman et al., 1979).

Given a decision to undertake some form of cattle ownership, the Burkinabé smallholder then has three basic options to do so, defined from the standpoint of how long the cattle are kept in the farm. The first option is the one that predominates in both Burkina Faso and all of savanna West Africa (Delgado, 1979a; Delgado, 1979b). This is the ownership of cattle that are entrusted year-round to transhumant cattle herders, typically of the Fulani ethnic group. Farmers reap the advantages of ownership inherent in meat price speculation, but lose use of by-products such as milk and manure. In this system, managerial and ownership inputs are distinct, while the primary resource requirement for participation is capital. The cattle entrustment system is the benchmark for all mixed farming systems in the region to be judged against.

The second option for smallholder cattle-raising lies in variants of the ninety-day intensive on-farm feeding model. Typically, large-framed but relatively emaciated cattle are bought at the end of the cropping season, stable-fed a large ration of high energy feeds and farm-produced roughage, and sold when livestock prices are highest at the end of the dry season. The key elements of the cattle fattening model are use of farmers' time outside the cropping season, securing rapid compensating weight gains for previously undernourished stock, and taking advantage of seasonal price rises (Delgado, 1980).

Smallholders may wish to keep cattle year-round for dairying, for growing out beef cattle under their own management, or to use oxen draft cultivation. For present purposes, the latter is defined as the keeping of a pair of oxen year-round on the farm for draft purposes, possibly selling them off for meat at age ten. Dairying in Burkina Faso on smallholder farms is the almost exclusive domain of specialized herding groups such as the Fulani. Milk yields occur only during and shortly after the rainy season and are very low. Smallholder dairying by predominantly crop-farming groups typically only occurs in the presence of externalities such as free high energy feed supplements from a nearby brewery, cotton gin, or sugar mill. The economics of dairying are complex and go beyond the scope of the present paper. However, it is clear that research should be directed not only at animal productivity, but also at means to improve distribution systems from a sanitation and cost perspective (Delgado, 1979b; Jahnke, 1982).

The "growing out" option involves keeping or breeding cattle year-round on the smallholder farm. Typically it would be done in conjunction with other mixed farming practices, such as dairying or oxen draft cultivation, but it is important analytically to consider each component part in isolation. The ownership benefits of cattle in terms of meat sales are presumably the same whether cattle are entrusted or kept year-round. In fact, without supplementary feeding, cattle kept year-round would probably do less well than entrusted cattle, because an important rationale for the institution is to move the animals sig-

- 2'

nificant distances away from the village in the dry season, to lusher pastures. Cattle given supplementary feeding in the dry season are better analyzed under the ninety-day feeding option.

Thus, the pure "growing out" option, or the keeping of cattle year-round on the farm, only has the extra benefit to the farmer of use of manure and milk. The extra cost is that the maintenance of the animals now requires a substantial labor allocation by the farmer to this end, both directly for animal maintenance and indirectly through forage crops or other activities to purchase feeds. The desirability of this option then is a trade-off of the expected benefits to the expected costs. However, it should be noted that if the cattle entrustment option is disappearing due to diminished power of traditional authority in the countryside, then growing out year-round on the farm may be the only way to secure the ownership benefits of investment in cattle. This would significantly boost the marginal returns to labor expended on animal maintenance compared to other options.

Perhaps because of recognition of low rates of return to labor in growing out two cattle under smallholder conditions, and of the importance of labor bottlenecks, much emphasis was put in the late 1960's in the Sahel on associating growing out of cattle with use of stock as a farm power source (Boudet, 1969; Delgado, 1979a). Even before this, the oxen draft option had long been advocated for West Africa, and Burkina Faso in particular (Barrett et al, 1982). Nevertheless, adoption rates have been highly variable across locations and generally low compared to Asia. Orders of magnitudes are indicated by the estimate of one plow for every 190 cropped hectares in Burkina Faso in 1977, compared to approximately one for every three to four hectares in India (Delgado and McIntire, 1982). At the present time, the best guess of the extent of use of animal draft cultivation, including donkey traction, is that it covers 15 % of cropped area in the West African semi-arid tropics (Matlon, 1987; Nagy et al., 1988). The key to the puzzle of why mixed farming is more prevalent in some areas than others within this zone lies both in its impact on farm resource use and in the factors affecting the relative opportunity costs of resources (Delgado, 1979a; Delgado, 1984; McIntire et al., 1988; Pingali et al., 1987).

3. Mixed Farming and Resource Use

Where arable land is in short supply, growth in agricultural output requires increased input in terms of soil amendments, fertilizers, improved seeds, and correspondingly changed practices. This invariably results in higher labor input per unit of land compared with traditional technology (Norman, 1978). In this context, it is interesting to note that examples of smallholder farming systems involving cattle kept year-round on the farm appear to come primarily from countries with relatively scarce arab e land, in both Asia (e.g. Japan, Taiwan, parts of India) and Africa (Ethiopian and Kenyan highlands). This leads to the general hypothesis that mixed farming is a practice that permits higher labor input per unit of land in a profitable manner.

Two implications arise from this for present purposes. First, if the hypothesis is correct, mixed farming of the type investigated here will become more attractive over time as agricultural population density increases. Second, efforts to promote mixed farming in areas where arable land scarcity is not yet a problem will need to pay particular attention

to the impact of proposed interventions on peak period labor requirements, the binding constraint on output in these systems (Newman et al., 1979).

Jahnke cites a highly revealing case study by Ludwig of mixed farming on densely settled Ukara Island of Lake Victoria (Jahnke, 1982). Following the practices of farmers both on the island and after migration to the sparsely-settled mainland gives a close approximation to a controlled test of the general hypothesis. At the time of the study, land availability for a family of five was limited to one hectare, the fertility of which was maintained by two to three cattle and several small ruminants tended year-round by "almost 2/5 of [family] work capacity" (Jahnke, 1982). Returns to labor input were very low. Migrants from the island to the mainland quickly abandoned maintenance of the animals on the farm in favor of shifting cultivation and extensive systems of stockraising (Jahnke, 1982; Ruthenberg, 1980).

Before-and-after or appropriate cross-sectional data to judge the overall impact of large stock-keeping on labor input to African smallholder farms are notoriously hard to find. The overall impact on labor input needs to be assessed, not only in terms of time spent maintaining the animals, but also in terms of changes in labor input to cropping and to non-farm income-producing activities.

While the entrustment option does not involve significant sustained labor input to stockraising by farmer-owners, ninety-day feeding models concentrate farmer input in the nonagricultural season. Thus, in the latter case, farmers are likely to increase total labor input to farming (as opposed to non-farming) activities. Furthermore, this can be thought of as increasing labor input per unit of land, especially if crop by-products are an important part of the model. The overall impact of intensive feeding technologies on household income will depend upon the opportunity cost of capital and labor in terms of non-farming activities during the dry season. We will see below that this can be a substantial cost.

Evaluation of oxen cultivation as a land or labor-augmenting technology depends not only upon direct labor input to livestock maintenance, but upon the effects of oxen draft cultivation on cropping patterns, labor allocation per hectare, and foregone activities from the capital and labor tied up outside the cropping season. The key point is that of all the year-round mixed farming models proposed for the Sahelian conditions, oxen draft cultivation has the best chance of success, provided that two conditions are satisfied. First, potential labor savings per hectare of cropping in the peak period and any extra benefits of the enterprise must compensate for time and money spent maintaining the team. Second, these benefits need to be competitive with non-farming uses of time and money. Oxen draft cultivation should provide the best showing for mixed farming under these conditions; problems encountered would presumably be amplified for other forms of year-round mixed farming in the same environment.

A major empirical analysis of the impact of oxen draft cultivation is available for Eastern Burkina Faso (Barrett et al., 1982; Lassiter, 1982). By concentrating upon only those villages of Barrett et al. sample where oxen cultivation was present and contrasting results from different sections of their study, it is possible to give a satisfactory picture of the intensification aspects of oxen draft cultivation, its opportunity cost in terms of other activities, and thus of year-round mixed farming in general in Eastern Burkina Faso.

Table 1 shows comparative data for 24 hand hoe cultivating households and 44 oxen cultivating households that also cultivated on average 40 % of their holdings manually

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(Barrett et al., 1982). The fact that farmers facing severe seasonal bottlenecks prefer to cultivate part of their holding manually confirms behavior observed and predicted in other farming systems studies in different parts of Burkina Faso and elsewhere in Savanna West Africa (Barrett, 1982; Delgado and McIntire, 1982; Jäger, 1986; McIntire, 1981; Sargent et al., 1981). A striking result of table 1, reported earlier by Barrett et al. is that oxen draft farmers do not cultivate a significantly greater acreage per worker than hoe farmers, despite the availability of "free" land (Barrett et al., 1982). Thus, oxen draft cultivation does not appear to be a land extensification technology here.

Table 1: Comparative cropping inputs and outputs in Eastern Burkina Faso oxen cultivation zones (means per farm household, 1978)

	Hoe Cultivators (N=24)	Oxen Draft Cultivators (N=44)		
		Plowed land only	All land	Including labor for plow team maintenance
Land (ha.)	3.89	4.08	6.89	6.89
No. of active workers	3.28	–	5.41	5.41
Land per active worker (ha.)	1.19	–	1.27	1.27
Labor hours to cropping (worker equivalent hours)	2,665	1,938	3,863	5,092
Peak labor hours[a] (WEH)	1,013	620	1,352	1,572
Labor hours per active worker	813	–	714	941
Peak labor hours per active worker	309	–	250	291
Labor hours per ha	685	475	561	739
Peak labor hours per ha.	260	152	196	228
Net crop income per labor hour (CFAF)	29.5	–	37.9	28.7
New crop income per peak labor hour	77.6	–	108.2	93.0
Household income per active worker	34,669	–	31,055	31,055

Note: [a] May 29 to July 23, 1978. The share of total labor going to crops in peak periods is taken as 38% for hoe cultivators and 32% for oxen draft cultivation, following Lassiter's data for all hoe and animal traction zones (15, p 83). Note that the data in the table pertains solely to the oxen villages of the sample.

Sources: Compiled from data in Barrett **et al.** (1982), Tables 4.15, 4.19, 5.2 and team maintenance data on page 66; also see note above.

On the other hand, both total labor hours and peak June-July cropping labor hours are lower per hectare of plowed land. This is also true for all land of the oxen draft sample, taken as an average. Furthermore, labor hours per active worker on pure hoe farms were higher than labor hours to cropping on oxen draft farms. However, if labor allocated to maintaining the plow team is included, total household labor input per hectare of cropped land is higher, even though labor during peak season is still lower, although less so, than in the pure hoe case. Similarly, total labor hours per active worker are higher in the oxen draft case than among hoe farmers when team maintenance is taken into account.

The interpretation of the above results is that oxen draft cultivation in a land-abundant environment apparently permits the shifting of labor input from the June-July peak to other times of the year (Barrett et al., 1982; Lassiter, 1982). However, oxen draft cultivation in this case does involve intensifying total labor input per unit of land. The profitability of this intensification ex post is shown in the bottom of table 1.

Net crop income per hour of cropping labor and per hour of peak cropping labor was significantly higher on oxen farms than hoe farms, as reported earlier by Barret et al. (1982). Nonetheless, this was not the case in the aggregate if labor required to maintain the team is added to cropping labor. The results show a marginal – and possibly insignificant – fall in the average product of labor on oxen farms relative to hoe farms. However, oxen farms are still better off in this respect if only peak season labor is considered. Finally, it should be noted that the average product of land is very marginally higher in the oxen case.

The bottom line of table 1 contains important insights into the opportunity cost of household resources as a barrier to mixed farming. Even though oxen draft cultivation was associated with favorable effects on the average product of labor (per hour), despite higher aggregate labor input, the average household income per active worker was lower in the oxen draft sample than on the hoe farms. Even higher livestock earnings for the oxen draft sample does not change this result. This is because of significantly greater income for the hoe farmers from nonagricultural trading and artisinal activities carried out outside the peak agricultural season. Barrett et al data show that these activities accounted for more than one third of household income of the hoe farmers on average, and that these receipts were more than 2½ times as great as comparable ones for oxen farmers (Barrett et al., 1982). The resources required to secure these receipts are precisely capital and labor, both of which oxen farmers had tied up in their team and equipment.

In sum, the Eastern Burkina Faso case study of oxen draft cultivation illustrates a broader problem for mixed farming in the Sahel in the late 1970's. This was that the opportunity cost of labor and capital in nonagriculture was high relative to the extra benefits secured from mixed farming under relatively land abundant conditions. This pessimistic finding would change if the value marginal product of labor in agriculture were to rise relative to nonagriculture due to either technological change or policy reform (or both). Furthermore, as land becomes less abundant, the agricultural productivity of mixed farmers will probably increase relative to pure crop farmers because of manure use (whether or not it declines absolutely), also favoring the case of mixed farming. The next section explores these hypotheses in greater detail.

4. Mixed Farming and Changes in Incentives

The preceding provides the background for assessing the effects in isolation of marginal changes in incentives on the overall profitability of mixed farming as defined above. Incentives are considered first from the cost side, through the opportunity cost of resources used in mixed farming in terms of non-mixed farming activities. Then they are considered from the output side in terms of yields and prices. Clearly, interaction terms are not nil, and the results should be interpreted subject to the usual partial equilibrium reservations. The analysis is summarized in table 2.

Other things being equal, a rise in the opportunity cost of land – very low in land-abundant societies – increases the profitability of keeping cattle year-round on the farm and lessens the value of entrustment strategies. This is because maintenance of soil fertility through re-incorporation of animal dung and green manures (made easier with oxen draft cultivation) is relatively more important. Thus, year-round mixed farming is more likely to be present in close-settled zones.

Other things being equal, a rise in the opportunity cost of labor favors cattle entrustment unambiguously from the owner's point of view. If the higher opportunity cost of labor is primarily in the peak agricultural season, then dry season feeding and oxen draft strategies are also favored. However, the reverse is the case if the opportunity cost of labor increases instead in other times of the year. Year-round growing out strategies are unambiguously harmed by a rising opportunity cost of labor in non-livestock terms.

Table 2: Hypothetical effects on mixed farming incentives of changes in input and output incentives[a]

	Increasing Opportunity Cost of (i. e. Scarcer)				Increase in	
	Land	Labor	Capital	Farm by products	Crop prices or yields	Beef prices or yields
Effects on: Cattle entrustment	–	+ –	–	+	0 or –	+
90-day Feeding	0	Peak: + Non-peak: –	–	– –	0 or –	+
Year-round growing out	+	– –	–	–	–	+
Oxen draft cultivation	+	Peak: + Non-peak: –	– –	–	+	–

Note: [a] Partial equilibrium effects, **ceteris paribus.**
Source: See text.

Since livestock is a significant placement of capital for smallholders, a rise in the opportunity cost of capital in terms of nonagricultural trading, say, is unambigously harmful to mixed farming, especially to oxen draft cultivation, which also necessitates investment in equipment. This view is consistent with the results in table 1, where non-oxen households appear to be relatively more heavily engaged in nonagricultural activities.

A column in table 2 is devoted to farm by-products because they are frequently assumed to be free goods by evaluators of mixed farming projects. Nonetheless, they do have alternative uses as feedstuffs for small ruminants, fencing materials, and fuel (Delgado, 1979a; Delgado, 1979b). As such, their opportunity cost outside mixed farming as considered here may be rising. This would unambiguously favor cattle entrustment compared to keeping cattle on the farm.

On the output side, price policies or technological change could raise the returns to cropping. In land-abundant societies, this will not affect the opportunity cost of land. However, it does decrease the attractiveness of growing out strategies, because of crop-livestock labor trade-offs. Where the returns to dairying and feeding are high enough to justify feeding concentrates, which is rarely the case in West Africa under current nominal prices, a rise in crop prices will tend to discourage mixed farming, other things equal (Delgado, 1980; McIntire et al., 1988). Finally, under the conceptualization of oxen draft cultivation developed above, higher crop prices should improve the attractiveness of oxen draft power.

An increase in beef producers' revenues will be beneficial to all livestock owners. Although this is also true for owners of plow oxen who may plan to sell their team for beef at age ten, the net effect is probably to discourage oxen draft cultivation. This is because oxen cultivators would now have a greater incentive to roll over their oxen capital in beef sales, rather than to risk it in oxen draft cultivation.

5. Relative Trends in Agricultural Incentives in Burkina Faso

The nature of available data and the lack of an explicit "representative" model of farm inputs and returns suggests considerable caution in inferring trends in farm level financial incentives in Burkina Faso over the last two decades, and their effect on the profitability of various mixed farming strategies. Nevertheless, the above provides a framework for interpreting the probable impact of broad movements in opportunity costs and prices; this section analyzes some implications of these trends for policies designed to promote mixed farming.

Indices are given in table 3 for key variables. Money values are deflated by a low-income urban price index to adjust for inflation. Movement in the indices shows the change in relative position of different indicators since 1973. Inspection of the annual data since 1967 (not shown) suggests that it is useful to distinguish trends up to the early 1980's from trends thereafter. The analysis below is therefore based on three scenarios: (a) 1970's type growth; (b) 1980's type stagnation, or (c) the 1971-86 "long-term trend". Growth rates in the table are simple annual averages between the mid-points of three year average values.

Table 3: Indicators of deflated[a] opportunity costs in rural Burkina Faso 1967–1986.

Year	GDP	Low-Income Urban Consumers' Food Price Index[b]	Burkina Faso Minimum Wage Structure[c]	Ouagadougou Retail Beef Price[d]	Burkina Faso Peanut Producer Price	Burkina Faso Gross Producer Revenue Per Ha. of Cotton[e]	Rural Pop. Density per Sq. km of Ag. Land
3 Yr. Avg. Of Indices, 1973 = 100							
1967 – 69	–	80	97	106	108	87	–
1971 – 73	96	93	98	95	98	94	99
1977 – 79	127	110	134	153	104	173	108
1981 – 83	135	124	122	179	198	171	110
1984 – 86	140	151	110	140[f]	150	261	116
Simple Avg. Annual Change (%)							
71/73 – 77/79	5	3	6	10	1	14	29
77/79 – 84/86	1	5	– 3	– 1	6	7	1
Total Change (%)							
71/73 – 84/86	46	63	13	47	52	178	17

Note [a] Except for nominal density data, nominal indices are deflated by the Ouagadougou low income cost of living index.
[b] Food indices deflated by low income CLI.
[c] Minimum agricultural wages are 90 percent of minimum industrial wages by law.
[d] Undifferentiated quality bone-in beef until 1981; from 1982 – 1985, the prices is for beef with bone.
[e] Official cotton producer price times average yield per hectare.
[f] Omits missing value for 1986.

Sources: Unless otherwise indicated, data for Burkina Faso (1967 – 1981) are compiled from series reprinted in: Republique Française, Ministère des Relations Extérieures, (25). The 1980 and 1981 Ouagadougou beef prices are from unpublished data of the Government of Burkina Faso, Office National de l'Exploitation des Resources Animals. Cotton yield data and total agricultural land (1981 – 1985) are from FAO, various issues of (9). Rural population density figures (thru 1980) and GDP are from the World Bank, (32). The 1985 – 86 population and the deflation factor are from IMF, (12). Cotton producer prices are from World Bank, (29). Peanut producer prices through 1983 are from Haggblade (10) subsequent peanut prices and the 1986 cotton producer price are from USIAD, (28). The consumer price index, the minimum wage structure, and the Ouagadougou retail beef price, all for 1982 – 1985, are from Institut National de la Statistique et de la Demographie, (11).

Overall, the trends show significant growth of GDP in the 1970's and stagnation in the 1980's. Food prices grew fairly steadily relative to other prices over the 1971-1986 period, with this phenomena accelerating somewhat in the later part of the period. Real minimum wages grew in the 1970's, but fell in the 1980's. Beef prices grew rapidly relative to other prices during the 1970's, but fell in the 1980's in real terms. Cash crop unit prices increased in real terms in the 1980's, under "Structural Adjustment," as shown by the indices for peanut procurement prices. Similar events for cotton prices maintained the real increase in gross farm revenue from cotton cultivation in the early eighties (exclusive of input costs). This was the case despite the fact that the growth in gross cotton revenue per hectare was half that of the 1970's when cotton yields were rising rapidly in Burkina Faso. Finally, population density in the arable parts of the country continued to increase steadily, although the rate of growth decelerated slightly over time (this deceleration is exaggerated by rounding in the table). Increased outmigration may have accounted for the deceleration in growth rates.

Overall, between the late 1960's and the mid-1980's, it seems to have become relatively more attractive to produce cotton, where soil permits, relative to most everything else. Grain farming became better remunerated relative to city life, as did beef and peanut production. Yet beef prices lost ground relative to food crop prices in the 1980's, after a strong improvement in this relationship during the 1970's. Finally, rural population density increased to the point where the assumption of land-abundance was no longer appropriate for major parts of the country (on average, 47 inhabitants per km^2 of the agricultural zone in 1986).

6. Implications for Mixed Farming Technologies

Extrapolation from these indicators is speculative at best, and must rely on putting these trends in context. In terms of the column variables of table 2, it is probable that the opportunity cost of land was not a major factor in the 1970's, but became so in the 1980's, especially in the "high potential" areas of the southwest suitable for cotton and maize.

The opportunity cost of labor in rural areas during the 1970's was driven primarily by developments in coastal countries and by nonagriculture (Delgado and Mellor, 1984). Thus even though beef and cash crops were becoming much more profitable relative to cereals during the 1970's, it is probable that migration or non-agricultural investment would pre-empt investment in mixed farming technologies, especially outside the cotton zone.

In the 1980's, however, the rate of growth of returns to beef production and cash cropping was not increasing significantly relative to cereals. The relative rate of return to migration was falling. Domestic agricultural activities generally did well relative to nonagricultural activities and extra-territorial migration. The latter were in the doldrums, because of both internal difficulties and stagnation in the coastal countries. Thus it is arguable that the opportunity cost of capital invested in agriculture in terms of nonagricultural uses declined, while the opportunity cost of labor also fell. Furthermore, the latter was probably due more to lower prospects of lucrative returns from migration than to population growth per se. Other things being, equal these developments are likely to be stimulative

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of mixed farming in general. Within mixed farming, higher real prices for cereals and cash crops are likely to stimulate animal traction, while lower beef prices and higher feed costs are likely to discourage beef production on farm.

Thus, in the medium-run, the outlook for oxen draft technologies looks good, especially in the "higher potential" 1 cash crop zones, and particularly to the extent that better draft equipment will help exploit the potential for these technologies to spread labor input across seasons. As was argued above and has been conclusively demonstraed by Pingali, Bigot and Binswanger, increasing population densities will of themselves favor the adoption of intensification-oriented technologies, such as oxen draft cultivation. Furthermore, increased population densities will also lead to the breakdown on the traditional entrustment relationship, as herders and farmers are pushed together (Delgado, 1979b). In that case, farmers who still wish to place wealth in cattle will need to find a use for them on the farm.

However, the other main factor influencing the relative profitability of oxen cultivation is less certain to continue. This is the recent relative decline in the opportunity cost of capital and labor in agriculture in terms of non-agricultural uses. When the coastal countries regain their 1970's growth paths, it can be expected that both relative beef prices and labor costs in the inland areas will skyrocket, as they did in the 1970's. When and if this happens, the relative returns to investment in beef production and migration will rise, to the possible detriment of farming systems improvement strategies based on farmer investments of time and capital in animal traction technologies.

Summary

Keeping cattle on smallholder farms, through some combination of animal traction, animal fattening, or dairy technologies, has long been a major theme of agricultural development programs in tse-tse free parts of West Africa. Yet mixed farming technologies of this type remain rare in crop producing parts of the zone. The paper lays out a conceptual framework for understanding the economic rationality of this phenomenon, by exploring the interrelationships among the options available for using farm household productive resources in West Africa and the rescource use impacts of different mixed farming practices involving cattle. These interrelationships are central to the relative incentives facing farmers to adopt mixed farming practices as compared with using resources in pure cropping and non-agricultural activities. A hypothetical case is made for the impact of changes in the relative values of specific primary factors on the relative attractiveness to farmers of specific mixed farming practices.

The case is made more concrete by an application to Burkina Faso, where the relative opportunity costs to farmers of land, labor, and capital have evolved substantially in relation to each other since the late 1960's largely in response to macroeconomic developments in the entire West African region, but also in lesser measure to increased population density. These trends are traced using broad indicators at the national level. It is concluded that rapid urban and coastal growth in the 1960's and 1970's had the impact of discouraging investments of farmers' time and money in mixed farming using cattle, especially animal traction. However, urban and coastal economic stagnation in the

region during the 1980's was conducive to investments in mixed farming in general, and animal traction in particular. Increased population density also favored this process. However, resumption of earlier growth paths, when and if it occurs in the coastal countries, is more likely to favor livestock activities other than oxen draft cultivation in the inland countries.

References

1. *Barrett, V., G. Lassiter, D. Wilcock, D. Baker and E. Crawford.* 1982 "Animal Traction in Eastern Upper Volta: A Technical, Economic and Institutional Analysis." MSU International Development Paper No. 4, Michigan State University, E. Lansing.

2. *Boudet, G..* 1969. "Réflexions sur l'Association Agriculture - Elévage." In Colloque sur l'Elvage. Ed. IEMVT, Paris, 225-230.

3. *Delgado, C.L.* 1979a. "Livestock Versus Foodgrain Production in Sooutheast Upper Volta: A Resource Allocation Analysis." Ann Arbor: Center for Research on Economic Development, University of Michigan.

4. *Delgado, C.L.* 1979b. "The Southern Fulani Farming System in Upper Volta: A Model for the Intergration of Crop and Livestock Production in the West African Savannah." African Rural Economy Paper No. 20, Michigan State University.

5. *Delgado, C.L.* 1980. "Livestock and Meat Production, Marketing and Exports in Mali," in Livestock and Meat Marketing in West Africa, Volume III: Ivory Coast and Mali. Ann Arbor: Center for Research on Economic Development, University of Michigan.

6. *Delgado, C.L.* 1984. "The Economic Context of Mixed Farming in Upper Volta: A Conceptual Framework" Paper prepared for the International Livestock Center for Africa Conference on Livestock Policies. Addis Ababa. (Mimeo)

7. *Delgado, C.L. and J. Mellor.* 1984. "A Structural View of Policy Issues in African Agricultural Development." American Journal of Agricultural Economics. (66) 5 Dec. 1984 665-670.

8. *Delgado, C.L. and J. McIntire.* 1982. "Contraints on Oxen Cultivation in the Sahel." American Journal of Agricultural Economics 64(2): 188-196.

9. *Food and Agriculture Organization (FAO). Various years. Production Yearbook. Rome, Italy.*

10. *Haggblade, S.* 1984. "An Overview of Food Security in Upper Volta." Report prepared for USAID/Upper Volta.

11. *Institut National de la Statistique et de la Demographie.* 1986. "Annaire Statistique du Burkina Faso." Ministère de ka Planification et due Développement Populaire.

12. *International Monetary Fund.* 1987. International Financial Statistics Yearbook.

13. *Jaeger, W.K.* 1986. Agricultural Mechanization: The Economics of Animal Draft Power in West Africa. (Boulder: Westview Press, 1986).

14. *Jahnke, H.E.* 1982. Livestock Production Systems and Livestock Development in Tropical Africa. Kiel: Kieler Wissenschaftsverlag Vauk.

15. *Lassiter, G.C.* 1982. "The Impact of Animal Traction on Farming Systems in Eastern Upper Volta." Unpublished Ph.D. Thesis, Cornell University.

16. *Matlon, P.* 1987. "The West African Semiarid Tropics," Chapter 5 in J. Mellor, C. Delgado and M. Blackie eds., Accelerating Food Production in Sub-Saharan Africa. (Baltimore: Johns Hopkins University Press, 1987).

17. *McIntire, J.* 1981. "Two Aspects of Farming in Central Upper Volta: Animal Traction and Intercropping." Village Studies Report No. 7, ICRISAT West Africa Economics Program.

18. *McIntire, J., D. Bourzat and P. Pingali.* 1988. "Crop Livestock Interactions in Sub-Saharan Africa: Technologies and Research Priorities" (forthcoming).

19. *Nagy. J., J. Sanders and H. Onm.* 1988. "Cereal Technology Interventions for the West African Semi-Arid Tropics." Agricultural Economics (2) 197-208.

20. *Newman, M., I. Ouedraogo, and D. Norman* 1979. 'Farm Level Studies in the Semi-Arid Tropics of West Africa." Paper presented at Workshop on Socioeconomic Contraints to Development of Semi-Arid Tropical Agriculture, International Crops Research Institute for the Semi-Arid, Hyderabad, India.

21. *Norman, D.W.* 1978. "Farming Systems and Problems of Improving Them," in Kowal, J. M. and A. H. Kassam, Agricultural Ecology of Savanna: A Study of West Africa. Oxford: Clarendon Press.

22. *Pingali, P., Y. Bigot, and H. Binswanger.* 1987. Agricultural Mechanization and the Evolution of Farming Systems in Sub-Saharan Africa. Baltimore: Johns Hopkins University Press.

23. *Ranade, C.G., D. Jha and C. Delgado.* 1984. "Technological Change, Production Costs and Supply Response." Ch. 11 in J. Mellor and R. Ahmed, eds., Agricultural Price Policy for Developing Countries (Baltimore: Johns Hopkins University Press, 1988).

24. *Reardon, T., P. Matlon and C. Delgado.* 1988. "Coping With Household-Level Food Insecurity in Drought-Affected areas of Burkina Faso." World Development, Vol. 16 (6).

25. *République Française, Ministère des Relations Exterieures.* 1983. "Facteurs d'Inflation en Côte d'Ivoire et en Haute-Volta." Etudes et Documents No. 56, Août.

26. *Ruthenberg, H.* 1980. Farming Systems in the Tropics. Third edition. (Oxford: Clarendon Press)

27. *Sargent, M.W., J. Lichte, P. Matlon and R. Bloom.* 1981. "An Assessment of Animal Traction in Francophone West Africa." African Rural Economy Program Working Paper No. 34, Michigan State University, E. Lansing.

28. *United States Agency for International Development.* 1988. "Burkina Faso: Prospects for Accelerated Economic Growth." APAP Technical Document No. 505.

29. *World Bank.* 1988. Cotton Development Programs in Burkina Faso, Côte d'Ivoire, and Togo. World Bank, Operations Evaluating Department, Washington, D.C.

30. *World Bank.* 1983. World Tables: The Third Edition. (Baltimore: Johns Hopkins University Press)

31. *World Bank.* 1987. World Development Report. (Oxford: Oxford University Press)