DISCUSSION PAPER - A REVIEW OF THE MAIZE COMMODITY SYSTEM IN GHANA

by Gideon Onumah and Jonathan Coulter, NRI, May 2000

1. Introduction

Maize is by far the most import cereal crop in Ghana, exceeding total output and acreage planted for rice, millet and sorghum put together. Though the crop is adapted to nearly all the agro-ecological zones of Ghana, production is concentrated in the forest-savanna transition zone comprising the Ashanti, Brong Ahafo and Eastern Regions. Because it is not an important staple in this 'maize belt', it is grown mainly as a cash crop but farm holdings are small, between 1-2 hectares with only about 15% of maize farmers cultivating more than 2 hectares.

Consumption is concentrated in the southern regions, particularly in Greater Accra, where it is a traditional staple. This tends to magnify its perceived significance as a food security crop. According to some estimates, maize and other cereals account for about 60% and 50% of the calorie supply of rural and urban households respectively (World Bank, 1992). However, as shown in Table 1, roots and tubers (especially cassava) constitute a far more important source of calorie supply, providing about 65% starchy staple consumption in Ghanaian households compared to 12% from maize.

TABLE 1: ESTIMATED SHARE OF MAIZE IN DIRECT HUMAN CONSUMPTION OF STARCHY STAPLE CROPS

Crop	Production (Ktonnes)	Edible production	Estimated feed use* (Ktonnes)	Production net of poultry use (Ktonnes)	Calory weights	Calory-weighted production net of feed use	Calory-weighted production as % of total staples
Maize	1,056	740	54	686	348	238,728	12%
Rice	233	255		255	363	92,565	5%
Cassava	7,831	5,461		5,461	148	806,153	42%
Plantain	2,169	1,844		1,844	119	219,436	11%
Cocoyam	1,832	1,465		1,465	98	143,570	7%
Sorghum	372	260		260	332	86,320	4%
Millet	160	112		112	327	36,624	2%
Yam	3,360	2,688		2,688	114	306,432	16%
Total staples						1,929,828	100%
Total root crops						1,256,155	65%

Source: Production and edible production - MOFA estimates for 1999/2000
Calorific weights: USDA figures
*only includes commercial poultry production, as per estimates in associated feed paper
Backyard livestock feeding is treated as direct human consumption

2. Production trend

Since the mid-1980s production has generally exhibited an upward trend, as can be seen from Table 2. During the period 1985-89 it grew by over 20% per annum, albeit from the lowest point in 1983. Output growth averaged 7.4% per annum in the 1990s with total production stabilising around 1 million tonnes in the latter half of the period. In comparison, production of sorghum grew by 2.4% per annum in 1995-98, while millet output actually declined at an average annual rate of 0.85%. Rice production over the period grew by 18% per annum.

TABLE 2: MAIZE PRODUCTION IN GHANA (1970-98)

Year	1970-74	1975-79	1980-84	1985-89	1990-94	1995	1996	1997	1998
Output ('000 tonnes)	448.3	303.9	273.2	573.4	823.2	1,034.2	1007.6	996.0	1,015.5
Output growth (%)	-	-32.2	-10.1	109.9	43.3	25.6	-2.6	-1.15	1.96
Area planted ('000 ha)	420.8	291.0	383.0	503.2	589.5	688.6	665.0	651.6	696.6
Change in area (%)	-	-30.8	31.6	31.4	17.2	16.8	-3.43	-2.02	6.91
Yield/ hectare (tonnes)	1.06	1.04	0.71	1.14	1.39	1.51	1.52	1.53	1.46
RPP* index			160.4	105	84.4	85.4	77.3	118.5	94.4

Source: Compiled from PPMED (Statistics Division), Ministry of Food and Agriculture, January, 1999
* RPP – real producer price index (1979 = 100)

The rising trend in maize output is explained mainly by area expansion and marginal increase in yield as shown in Table 1 but occurred during a period of falling real producer prices[1].

2.1 Economics of production

Production system is changing in the 'maize belt'
In contrast with the traditional production systems in most parts of Ghana, maize cultivation in Ashanti and Brong Ahafo is becoming increasingly more intensive and mechanised. Use of tractors for ploughing and motorised transport from farms storage sites and markets is more common – access to these services is partly attributed to improved feeder roads in parts of the Brong Ahafo, which we visited. Planting pure stands of maize is also more common in the 'maize belt' than it is in other regions of Ghana where mixed cropping is predominant. This is mainly because farmers in this region see maize as a cash rather than subsistence crop. Cash rent payments are replacing traditional tenure arrangements involving rent-in-kind (usually

[1] This is consistent with the observation of decline in average maize retail prices by Badiane (1998).

one-third or half of produce) but long-term leases for maize cultivation are still uncommon.

Intensive cultivation increases need for fertiliser in maize belt

Intensive cultivation of maize and progressive shortening of land fallow periods has contributed to decline in soil fertility and increased the need for fertilisation in the 'maize belt'. Farmers in this region therefore report significant marginal returns to fertiliser use – anecdotal evidence obtained from Brong Ahafo indicates yield increases of about 50%[2] due to fertiliser application at recommended rates.

In the Offuman District for instance, yields of up to 4.8 tonnes/ha are reported by farmers applying fertiliser at the recommended rates and the average for such farms is claimed to be 4.06 tonnes/ha[3]. However farmers reported that yields drop to 1.5-2.0 tonnes/ha without the use of fertiliser (national average yield is estimated at 1.51tonnes/ha) and some indicated a preparedness to reduce acreage planted rather than quantity of fertiliser use to compensate for rise in input costs. This situation contrasts with the general picture of low incremental returns to fertiliser utilisation in maize production in Ghana as noted in studies by Morris and others (1999) and the explanation probably lies in the fact that our own observations, though far less scientifically based, relate to a region where conditions are most favourable and we have not sought to generalise about the country as a whole (see Box 1).

BOX 1: PROFITABILITY OF FERTILISER USE IN OFFUMAN AREA

Assuming a breakeven revenue per hectare of $314.32 (equivalent to the cost of production), the value-cost ratio (VCR) for use of fertiliser in the Offuman area can be computed as follows:

Value per tonne of maize	= $77.42
Yield per hectare with fertiliser	= 4.06 tonnes
A. Yield per hectare without fertiliser reported by Offuman farmers	= 2.0 tonnes
B. Yield per hectare without fertiliser as per national average	= 1.51 tonnes
Cost of fertiliser per hectare (at recommended rates)	= $72.62
Additional revenue per hectare in the case of A	= $159.48
VCR in the case of A (additional revenue/cost of fertiliser used)	= 2.19
Additional revenue per hectare in the case of B	= $197.42
VCR in the case of B (additional revenue/cost of fertiliser used)	= 2.72

- According to the accepted rule of thumb, VCR of 2 or more indicates that fertiliser use is profitable. The implication is that, it is profitable to use fertiliser for maize production in the Offuman and similar areas in the maize belt where intensive cultivation and consequent decline in soil fertility, result in significant increase in yield with fertiliser application.

Source: Authors

Production cost and competitiveness

Mechanisation appears to have marginal impact on production cost per hectare, the main saving being time, allowing the farmer to cultivate more hectares. The situation is, however, different in the case of fertiliser application. Crop budgets obtained from

[2] This is consistent with estimates by Pinstrup-Andersen (1976) that fertiliser contributes 55-57% of the rise in average yield per hectare.

[3] Average yield in the major maize producing districts of the Brong Ahafo Region as a whole is around 2.9 tonnes/ha.

official sources and through interviews with maize farmers (see Appendix 1), indicate that production cost per hectare is $314.32 where fertiliser is applied at the recommended rates but drops to $221 without fertiliser application.

Using an average yield of 4.06 tonnes/ha for farms applying fertiliser at the recommended rates, the cost of production per tonne of maize is $77.42, while the respective cost for non-fertilised farms with average yield of 1.51 tonnes/ha is $146.36. The indication from this, as further demonstrated in Box 2 is that the validity of any claim that Ghana has farmgate competitiveness in maize production depends on farm yields and tariffs on imports.

BOX 2: COMPARATIVE COST OF PRODUCTION AND IMPORTATION OF MAIZE IN GHANA

Average cost of production per tonne:

@ yields of 4.06 tonnes/ha	= $ 77.42	
@ yields of 2.9 tonnes/ha	= $108.39	
@ yields of 1.51 tonnes/ha	= $146.36	
Cost of imports (per tonne): –	white maize	yellow maize
Fob (Gulf of Mexico)	= $110.0(est)	= $ 95.0*
Freight and insurance	= 35.0	= 35.0
Port handling and clearing charges	= 13.5	= 13.5
Sub-total	= $158.5	= $143.5
25% duty and 10% VAT	= 54.37	= 13.0 (only 10% duty)
Total	= $212.87	= $156.5

Note: transport costs are not shown given the variable location of poultry production, with Kumasi favouring domestic production, and Greater Accra favouring imports
Data from Food Outlook (No.2, 2000)
Source: Authors

2.2 Fertiliser use in maize production

Ghana's fertiliser market was liberalised in 1992 and is dominated by a single importer (Wienco), which handles over 65% of the importation and 75% of wholesale distribution of fertiliser[4]. Imports, which peaked in 1989 (see Table 2) declined by over 50% in the immediate post-liberalisation period when subsidies were also withdrawn. There has, however, been significant recovery with 1997 imports amounting to 86% of total imports in 1989. Fertiliser application rates are standardised throughout the country and take little account of specific crop requirements and agro-ecological conditions. The small size of the market seems to limit domestic blending of crop-specific fertiliser that can improve nutrient utilisation efficiency and potentially lower its cost. It is estimated that to breakeven, the minimum sales the blender must make is 50,000 tonnes per annum, a figure which is higher than total imports in 1999 and almost double total sales by the largest importer (*pers. comm*.: Wienco).

[4] World Bank working paper on Maize, 1998

Demand weak but market has growth potential

Fertiliser use in Ghana is generally very low as in the rest of Sub-Saharan Africa[5]. It is estimated that only about one-quarter of Ghana's maize area receives inorganic fertiliser[6]. If the group of farmers using fertiliser applied at the recommended rates, estimated total demand by maize farmers alone in 1999 would be close to 67,000 tonnes (compared to imports of 42,315tonnes for all crops). Fertiliser utilisation at recommended rates on 40% of total maize area would raise demand far beyond 100,000tonnes per annum.

The weak demand has mainly been attributed to price increases resulting from the withdrawal of subsidies, the central argument being declining maize/fertiliser price ratios (as is evident in Table 2). On the basis of this, there have been demands for restoration of fertiliser subsidies. But this option is quite clearly not sustainable – at the 1999 levels of imports, the proposed subsidies would cost Government over $5 million per annum[7] *(about 23% of total Government expenditure on agriculture)*.

TABLE 2: FERTILISER IMPORTS, PRICES AND SUBSIDIES IN GHANA 1980-98

Year	1980	1984	1987	1989	1993	1995	1997	1998
Fertiliser import (tonnes)	60,460	38,350	38,070	65,239	20,160	28,140	56,163	42,315
Price per 50kg bag of compound 15-15-15 (cedis)	15	440	1,380	3,350	11,800	22,500	34,000	35,000
and (US $)	5.36	12.97	10.41	14.16	13.10	18.74	14.98	14.83
Price per 50kg bag of sulphate of ammonia (cedis)	12	295	820	2,350	7,800	16,000	22,000	22,000
and (US $)	4.29	8.70	6.18	9.24	12.02	13.33	9.69	9.32
Subsidy level (%)	65	45	42	15	0	0	0	0
Maize retail price per 100 kg bag - Accra (cedis)	100	2,038	5,387	5,300	11,072	24,708	64,326	59,309
Maize/fertiliser price ratio*	6.7	4.6	3.9	1.58	0.93	1.09	1.89	1.69
Fertiliser/maize price ratio**	0.3	0.4	0.5	1.26	2.13	1.82	1.06	1.18

Source: Ministry of Food and Agriculture (1995 and 1999)
*Price of 100kg bag of maize/price of 50kg bag of compound fertiliser (MOFA, 1995).
**Quantity of maize (kg) required to purchase 1kg of compound fertiliser.

[5] According to Pinstrup-Andersen et al. (1999) the average consumption rate of fertiliser in Sub-Saharan Africa is 10-15 kg per hectare.
[6] Estimates by Morris et al. (1999).
[7] Proposed at a stakeholders consultative meeting to develop a new agricultural sector policy in 1995 (MOFA, 1995).

There is also the perception that the high price of fertiliser is due to non-competitive structure of the domestic market. Apparently for this reason, the Agricultural Development Bank (ADB) entered the market in 1997 to purchase bulk fertiliser and distribute to its customers, particularly those in cotton production in the north. The emerging evidence suggests that this ad hoc intervention failed to reduce fertiliser prices to end users by any significant margin and disrupted the development of private distribution channels. It also raised questions about Government commitment to a policy of non-involvement in private-operated economic activities, and it is possible that the uncertainty so created may have undermined private initiatives to blend fertiliser locally.

Factors affecting fertiliser demand

The call for subsidies and the intervention by ADB focused primarily on increasing demand through reducing input cost. Our field observations, which are consistent with those of other researchers[8], suggest that other factors are even more important, the most crucial of these being the overall profitability of fertiliser use. Other factors include land tenure arrangements (with freehold or cash-rent leases favouring fertiliser use), cropping intensity and access to extension services and credit. That these conditions are emerging as features of the evolving production system in the maize belt (described above) explain why farmers in that region tend to use more fertiliser than in other parts of Ghana.

Profitability of fertiliser use can be measured using output/input price ratios (shown in Table 2) or the more refined value-cost ratio (computed in Box 1). Profitability can be improved either by output price increase or lowering input costs. Hence, it can be argued that recent (since 1997) ad hoc interventions that sought to artificially dampen maize prices contributed to weakening fertiliser demand by maize producers.

Table 2 shows that the local price of fertiliser in US dollar terms has remained stable since 1989 despite the withdrawal of subsidies. Currency depreciation, therefore, adds substantially to local cost build-up. High interest rates, also the result of macro-economic instability, is another factor that contributes to rising local fertiliser prices. Assuming 6 months of storage, interest and bank charges alone account for 32% of ex-port distribution costs and margins. The contribution of transport costs is 34% while trade margins (split between importer, wholesaler and retailer) amounts to 21%[9].

Promoting organic manure

One way of improving soil nutrient management in the face of rising cost of mineral fertiliser has been to explore the potential for organic fertiliser. Studies by IBSRAM suggest technical and economic potential for using poultry manure. However, access difficulty constitutes a major obstacle to wider usage of poultry manure because volumes required are large (about 4 tonnes/ha as estimated by Quansah et al., 1997) and can not be met in the surplus maize producing zones. The other major problem is the high cost of transporting and applying the manure, which is bulky.

[8] See studies by Morris et. al. (1999) and FAO/IFA (1999).
[9] Data from World Bank working paper on maize (1998)

2.3 Use of improved seed maize

Collaborative efforts facilitated development of improved varieties
The development of improved maize varieties has since the 1980s involved collaborative research between Crop Research Institute (CRI), IITA and CIMMYT with the Canadian International Development Agency (CIDA) providing funding. From stocks of 'breeder seed' produced by researchers, the Grains and Legumes Development Board (GLBD) produces 'foundation seed' which it sells to selected private farmers who produce 'certified seeds' for sale to maize farmers. Similar collaboration between GLBD, the Extension Services Department (MOFA) and Sasakawa-Global (SG) 2000 helped disseminate information about improved varieties and husbandry practices.[10]

Since 1984, the GLBD has released 12 new improved maize varieties, with on-station yields ranging from 3.6-6.0 tonnes/ha (including a popular variety 'obaatanpa' released in 1992 with yield of 4.6 tonnes/ha. Until recently the focus had been on producing open-pollinated varieties (OPVs) but in 1997 a hybrid variety (called 'mamaba') was released. According to CRI productivity of the hybrids tend to be more stable and 'mamaba' is early maturing and drought-resistant. Both 'mamaba' and 'obaatanpa' are described as quality protein maize (QPM) because the protein content has higher levels of lysine and tryptophan. This reduces the need for fishmeal and other higher value protein feedstuffs, thereby saving about $31 per tonne of poultry feed used (assuming a commercial poultry population of 3 million, the total savings for the industry could be close to $4 million per annum[11]).

Yellow maize production constrained by tariff regime
Attempts to promote local cultivation of high-yielding yellow maize varieties (e.g. 'golden crystal' released in 1972) have failed though it is preferred by the poultry industry because of its yolk-colouring effects. It has been said that an under-developed supply chain for yellow maize hampered domestic production but it is also quite clear that yellow maize producers are not protected as is the case with white maize farmers. While white maize is protected by a 35% tariffs regime (20% duty and 12.5% VAT), the same can not be said for yellow maize. Even though CEPS tariff schedule shows tariffs on imported maize to be non-discriminatory on the basis of produce colour, duties on imported yellow maize can be lowered to 10% or even waived completely if an official 'permit' is obtained from MOFA describing the import as a raw material in the poultry sector. Any VAT paid on the imports is also recoverable for similar reasons.

This situation makes yellow maize imports relatively cheap, and makes producers uncertain about market access. If such a discriminatory protection regime did not exist, poultry farmers would probably have been prepared to pay a premium price for the locally produced yellow maize because it will allow them to produce yellow yolks without spending on pigmentation, which costs upwards of $8 per tonne of maize incorporated into feed.

[10] A survey by Tripp and Marfo (1991) reported that one in four maize farmers in Ghana had some form of contact with SG 2000 through which they had gained awareness of the qualities of the improved varieties.
[11] Source: Crop Research Institute (1996) "Obatanpa – a new maize variety with high quality protein for feeding poultry" Factsheet – Cropinfo No. 23.

A few poultry farmers have indicated interest in developing outgrower schemes to produce yellow maize and could benefit from continued efforts by CRI and its collaborators to develop yellow QPMs. Success of these initiatives, which could benefit the Ghanaian poultry industry in the long term, however, require discontinuing the preferential tariff regime enjoyed by yellow maize importers. The trade-off between short-term input costs reduction and long-term competitiveness of the industry should be the basis for reviewing the existing policy.

Distribution bottlenecks and price disincentives discourage use of improved seed
Table 3 shows that production and use of improved seeds in Ghana grew rapidly in the early 1990s but has since stagnated. Certified seed accounts for only 6-7% of total seed maize requirement[12] in Ghana, despite awareness created by extension personnel.

TABLE 3: PRODUCTION AND SALE OF CERTIFIED SEED IN GHANA

Year	Quantity produced (tonnes)	Quantity sold (tonnes)	Price per 45kg bag (cedis)	Price per 45kg bag (US $)
1990	313	NA	10,000	30.67
1991	326	297	12,000	32.81
1992	449	326	15,000	34.32
1993	566	475	18,000	27.73
1994	816	816	27,000	28.22
1995	866	866	36,000	29.99
1996	1,050	1,050	36,000	21.98
1997	1,220	1,220	54,000	23.79
1998	1,000	825	70,000	29.66

Source: National Seed Service, Ministry of Food and Agriculture, 1999.

Studies (by Morris et al, 1999) show that the adoption of improved seed varieties has been hampered by lack of a well-developed inputs supply system. The recently privatised agricultural inputs supply system is struggling to establish itself and as a result seed distribution outlets are scarce in many areas. According to an official of GLBD and an inputs distributor, seed distribution outlets in the Ashanti Region are concentrated in 10 out of the 18 districts (*pers. comm*).

Again rising cost of certified seeds is seen as a major factor militating against increased utilisation. It is estimated that certified seeds cost about three times more than farmers' own retained seed valued at the average farmgate price. Use of retained seeds by farmers is also encouraged by the fact that the varieties released have all been OPVs. The shift to hybrids will mean that farmers can no longer do this without

[12] At the recommended 9kg/acre or 22.5kg/hectare, demand for seed maize use in 1998 amounted to 15,673.5tonnes, which is 1.54% of annual output. Certified seed maize produced therefore constituted 6.4% of total requirement in 1998.

significant loss yield and other quality characteristics. But it must be stressed again that the nominal price increases for seed maize in the 1990s reflect substantial currency depreciation.

In 1998 there was a notable drop in sale of certified seeds. This was attributed to depressed maize producer prices resulting from imports that distorted the market in 1997. What this suggests is that, as the new private distributors develop more accessible supply networks, it is important for Government to avoid interventions that distort producer price incentives.

3. Consumption

Carl Bro International AS (1991) estimated Ghana's usage of its maize output approximately as follows:

70%	traditional food preparations (e.g. kenkey), in the home and small-scale catering establishments
5%	seed
12%	animal feed
5%	industrial purposes
5%	exported (mainly through lively informal channels to Togo, Burkina Faso and to Niger)
3%	post-harvest losses[13].

They also estimated that approximately 50% of output was retained on farm and the remainder released to the market.

There is insufficient information is available to make a complete revision of Carl Bro's estimates, but we can say with some confidence, that seed use is only about 1.5%, and industrial usage about 0.5%. There remains some uncertainty over the quantity used in animal feed and exported. The figure for post-harvest losses may be on the low side, but is in line with research findings on this topic.

Maize use in animal feed

The poultry industry is by far the most important non-food user of maize. Estimating maize consumption by the sector is, however, hampered by lack of reliable data on the poultry population in Ghana. Livestock census figures from MOFA (Veterinary Services Department) over-estimate the population, having assumed a growth rate of 10% per annum, which does not reflect industry stagnation in the late 1990s. Rising feed cost and competition from imports are the main factors responsible for stagnation in the industry.

Based on the relatively more reliable data on day-old chicks, we have estimated demand for maize in the formal (commercial) sector at about 54,000 tonnes per annum[14]. This demand could rise if broiler production increased substantially to satisfy demand currently met by imports of poultry products, which have risen from 7,939 tonnes in 1997 to 12,267 tonnes in 1999[15]. To produce the latter quantity of poultry products would require approximately 37,000 tonnes of feed of which about 20,000 tonnes would probably be maize.

[13] The most thorough research carried out so far is ----------

[14] See calculations in our associated discussion paper on feed production and ingredients in Ghana

[15] Source: Livestock Planning and Information Unit, MOFA, 1999.

Currently, we estimate that maize imports (mainly of yellow maize) account for 10-15% of total maize use in the poultry industry. Utilisation of local maize and other feed ingredients is often hampered by irregular supply and inconsistent quality and high carry costs, as follows:

- Irregular and therefore unreliable supplies - Most stockholding is dispersed in small farm cribs, and there are few merchants with ready stocks for sale when required. There is very little forward contracting. Grain merchants with access to finance and drying facilities have become more common in recent years, but poultry farmers get much of their supplies from small traders working on a hand-to-mouth basis.
- Quality problems in certain consuming areas - Two leading Kumasi farmers to whom we spoke were not greatly concerned about quality, but a leading player in Greater Accra is prepared to discount local maize by 10-25% to compensate for quality inconsistency, particularly as regards aflatoxin and insect damage. The reasons for this difference is uncertain, but it may be because Ashanti and Brong Ahafo have more highly developed farming and maize trade and a greater number of mechanical driers than do the Regions supplying Greater Accra. Moisture content at the time of the major harvest (July to November) is in the range of 20-25%, and without rapid drying quality deterioration is likely to set in.
- High interest rates raise carry-cost for on-site stocking, and diminish the advantage of low harvest season prices. ADB and Barclays allow their poultry-farming customers to use credit to buy maize at harvest time and stockpile it for the lean season. Until the latter 1990s farmers have usually found this profitable, even at the high interest rates they had to pay (30 - 45% per annum during most of the decade), but in recent years the normal seasonal price pattern failed to materialise and they have sometimes made a loss. This in turn has made them reluctant to risk taking credit. We found one farmer who had opted not to stockpile in the 1999-2000 season only to find that the familiar price pattern had resumed - he is again losing money. Inevitably stocking decisions are speculative and poultry farmers will sometimes incur losses - however in this case avoidable Government intervention accentuated the risks.

Sub-regional trade in maize

Free trade in maize in the sub-region is significant but is not well tracked by official data. Anecdotal and published information indicates that Ghanaian exports are erratic and have been following a rising long-term trend, facilitated by generally supportive public policies. Exports really took off in 1996 in the light of poor supply within the Sub-Region, and for the first time maize registered as an important "non-traditional export". Official statistics show exports of 17,300 tonnes in 1996, 4,000 tonnes in 1997, 14,300 tonnes in 1998, and 1,100 tonnes 1999, but unrecorded exports are believed to be much more than this[16]. The major destinations are countries in the sub-region: Togo, Niger and Burkina Faso.

An important observation reported about the sub-regional trade in maize is that it is not uni-directional. There are flows between markets in the sub-region, influenced

[16] Reusse (1998) estimates that another 30,000tonnes was exported in 1996 was exported through informal channels, but we do not know how this estimate was derived.

mainly by traders trying to take advantage of arbitrage opportunities. This mechanism moderates price and supply variability in Techiman market, which is the single most important maize market in the country, and elsewhere. In the period of April to July, when prices in the Maize Belt normally peak, there are significant informal imports from Côte D'Ivoire and Burkina Faso.

Industrial uses – grits, starch, flour and fermented dough
Industrial utilisation of maize is currently very low but there are indications of significant growth potential.

Nestlé (Gh) Ltd. has been using between 350 and 500 tonnes of maize per annum for production of infant food, but currently buys from a single producer (Ejura Farms) because of high quality requirements, particularly with regard to aflatoxin.

Two of the country's three *brewery groups* have recently begun to use locally manufactured maize grits, and the other company is believed to be considering the possibility. One brewery is presently using 20 tonnes of grit per week, which translates to 34.5 tonnes of maize per week or 1,656 tonnes/annum. In the industry it is generally accepted that it is possible to substitute 21% of malted barley with maize grits and sugar without perceptibly changing flavour. If this occurred, demand for maize grits could rise to 3,400 tonnes/annum[17] (or about 5,800 tonnes of maize). Breweries stand to make major savings by using maize grits: the current cost of imported malt is around US$ 429 per tonne (including 10% import duty) delivered to Kumasi, whereas the cost of local grits cost is about 60% of this.

Much larger quantities of ingredients could be substituted if Ghanaian breweries followed the example of Nigeria. After a ban on imported cereals in the latter 1980s, Nigerian breweries found alternatives to imported malted barley, notably malted sorghum, maize grits and enzymes (needed where non-malted ingredients were used). Certain breweries were totally satisfied with the product obtained and now that the import ban has been removed will continue using local ingredients, providing they are cost-competitive. However, because the change involved substantial investment in new plant, some smaller brewers did not survive it, and some multinational brewers claim to have suffered because of the effects on flavour and brand image - and are consequently switching back to traditional sources.

The brewery market is of particular interest to Ghanaian farmers because of its rapid rate of growth. Despite a contraction in demand over the last year, brewers indicate that underlying demand is a growing one, at between 8% to 10% per annum.

While it is possible for the brewery industry to use more maize grits and flakes (and possibly sorghum cassava if a suitable product is offered), the livestock industry could potentially make profitable use of brewery wastes. Poultry farmers already make limited use of spent grain, but all the surplus yeast and whirlpool trub are wasted. Pigs thrive on liquid feed and would be the best option for using these wastes, but Ghana's swine industry is very small and low-tech. For use in the poultry industry,

[17] We estimate conservatively that Ghanaian breweries require about 16,000 tonnes of ingredients (malted barley or substitutes such as maize grits and sugar) to produce 1.0 million hectolitres of products, i.e. lager, stout and malt. Official import statistics show imports of malt rising from 10,400 tonnes in 1995 to 16,600 tonnes in 1999.

one would have to dry the ingredients, but except in the case of surplus yeast (crude protein content 44%), the cost is likely to be prohibitive. The only way to economically dry spent grain and whirlpool trub would be to use a virtually free fuel (e.g. sawdust, which is abundant in Kumasi), but high fibre content would limit inclusion rates. Probably the best option would be to develop local pig farms close to the breweries - if possible the wastes should be piped directly to the farms themselves. Maize is also used to make starch which has applications in the textile industry (see cassava paper*)*. Currently, there is only one major producer with output of about 2,000 tonnes, which is about 40% of Ghanaian demand for this product.

There are a number of small-scale enterprise which produce maize based cereal products, mainly for sale through up-market stores. Production figures are not available, but the total volume is likely to be less than 100 tonnes per annum.

Work by the Food Research Institute (FRI) indicates significant potential for processing maize into food products like breakfast cereals, grits (semolina) and dry, fermented dough. Composite flour production, substituting for up to 30% of wheat in bread flour (can be even higher in the case of biscuit production) has also proved technically feasible, which suggests a theoretical demand of 25,000tonnes per annum[18]. However, commercial millers are likely to be very hesitant because of the possible adverse effect on brand image, and because the addition of non-wheat flours results in denser breads which will not be acceptable to all customers. However there are indications that composite flours may be of more interest to bakeries, and particularly bakeries in rural areas**.**

The production technology and processing equipment for most of these products can be obtained from Food Research Institute (FRI)[19]. A number of entrepreneurs[20] have tried to take advantage of these opportunities but as far as we could ascertain market development is hampered by problems of inconsistent quality and supply of raw material, and market acceptability. Of equal importance is the lack of local skills in product development in the country – for carrying out market research, packaging and launching new products.

Based on the above discussion we estimate that current industrial use of maize in Ghana is of the order of 5,000 tonnes per year, i.e. around 0.5% of total production.

Post-harvest losses

An assessment of on-farm physical storage losses in Ghana[21] indicated that most regions were experiencing losses within the range of 6% to 8% for storage periods of 4 and 7 months duration. These are very high levels by international standards, and reflect the difficulties farmers experience in storing in a moist climate. Overall losses may be somewhat greater than Carl Bro's 3% estimate, particularly in areas of the Maize Belt where farmers often have to cope with large quantities of grain during the rainy season.

[18] Wheat imports for flour production in 1998 was 81,000 tonnes.
[19] FRI has also prepared a Quality Manual for Kenkey production and Maize Quality Standards for Kenkey.
[20] Including Elsa Foods and Rosafrik.
[21] Source: Offusu, quoted by Boxall and Bickersteth (1991)

4. Marketing and distribution system

4.1 Market supply chain

Traditional/informal trade is predominant
The maize supply chain is made up of a dominant traditional (informal) sector, consisting of a large number of small operators, and a modern sector handling not more than 40,000 tonnes per annum (or 8% of the marketed surplus[22]). The traditional chain supplies the household and catering sectors while the modern sector mainly sells to poultry farmers and industrial end-users. Informal traders make extensive use of public markets but their use of mechanical dryers is negligible, and maize sold may have up to 19% moisture. Modern traders, on the other hand, tend to handle dry grains with low aflatoxin levels and contracting is a growing phenomenon in this sub-sector.

The informal chain starts with assemblers of various sizes (ranging from those handling 20kg to 20 bags) – who buy directly from farmers. They finance their activities mainly from own resources and sometimes with advances provided by other traders. Buying from these and also directly from farmers, secondary assemblers ship produce to central supply (wholesale) markets like Techiman and Nkoranza. Produce weight at primary assembly points ranges from 135kg per bag for dry maize to 165kg per bag for wet maize. At the central supply markets standard weights average 130kg per bag.

Loaders: powerful arbiters in the informal sector in the absence of weight standards
Standard weight measures are usually not used, the measure being somewhat subjectively based on type and age of sack used. Loaders, therefore, play the additional role of being arbiters in weight disputes. This gives a group of loaders' leaders (termed 'gyatumfoo') considerable power in the market, with their fees reflecting not only loading charges but also their 'commission as agents' of traders[23].

'Market queens' facilitate trade in the face of constraints
The bulk of produce traded in central supply markets end up in wholesale markets in southern Ghana and in export markets in the sub-region. Illiquidity and lack of basic handling and storage facilities at markets are the main problems in the maize trade. In the face of these problems 'market queens' have emerged as the most influential group of traders in the southern wholesale markets, dominating trade in local produce with their role including:

- providing informal producer finance (to meet both production and consumption needs of farmers - often tied to produce supply/price agreements – exercising first option to buy produce);
- providing advances to itinerant assemblers (bringing supplies from the maize belt) including paying off immediate commitments to transporters and acting as one-stop 'clearing' point for them;
- providing suppliers' credit to small retailers; and
- controlling 'storage' facilities at markets.

[22] This is based on the FAO (1989) estimate of marketed surplus of maize being 50% of total output.
[23] At the Techiman market they charge about $1 per bag or $7.69 per tonne of maize.

The key to their power (including the ability to control supplies at markets and influence producer prices) lies in the long-term relationships they maintain with farmers, assemblers and retailers. The cost of losing this relationship appears sufficient to discourage other players from exploiting more beneficial terms from new market entrants who can not guarantee regular supply or market.

Modern sector: progressive but market share is marginal
Until 1990 the GFDC[24] dominated the modern sector of the maize trade but the corporation is virtually bankrupt and has ceased operations at most of its locations in the maize belt. The 1990s also saw the emergence of a group of new entrants, most of them with professional background. These traders often have integrated operations and have relatively better access to formal credit and trade using supply contracts with poultry farmers, other industrial users like the breweries and relief agencies.

The growing significance of contracting and the entrance of more modern traders seeking to apply trade standards suggest that it may be possible to reduce transaction cost, by encouraging trade by description rather than by sight as is currently the norm. Further reduction in distribution costs is possible as certain links in the existing chain, which add to the build up of costs e.g. fees/commission for loaders and council levies can be avoided or minimised. The share of the market controlled by this group can, however, experience significant growth only with improvements in drying and warehousing facilities and increased access to trade finance.

4.2 Drying and storage

Farmers store part of their crop to take advantage of seasonal price rises. However, larger farmers can do this more than smaller farmers who are constrained by the need to pay school fees and other demands to sell at low prices during the harvest season. Stockholding by traders is minimal and end-users, including poultry farmers, often lack sufficient finance to store large volumes even though they often have drying and grain storage facilities, and even where available, they experience high carry cost[25]. Grain drying is essential in the transition zone because the bimodal rainfall pattern means farmers can not rely on sun drying. This leads to substantial post-harvest losses and quality deterioration[26], a critical issue particularly where supplies to poultry and other industrial users are concerned[27].

Grain storage hampered by weak GFDC and market intervention
Until recently, off-farm storage and drying was mainly provided by GFDC. It started providing services in 1993, and increased rapidly until 1995/96 (as shown in Table 4), when more grain was handled than peak volumes at the end of the 1980s, at a time when the parastatal had been able to procure on its own account. However the system collapsed due to well known internal problems of GFDC, including deterioration and disappearance of stocks, and lack of insurance cover to deal with such losses. Default

[24] The corporation never exceeded 10% share of the maize market.
[25] The situation is due in part to high interest rates, at a time when seasonal price variations have been unusually depressed – partly a result of public policy.
[26] The moisture content of maize at harvest can be as high as 24%, especially in July-September when most of the crop is harvested at the time of the minor season rains.
[27] There has also been recent concern about the quality of maize used in preparing traditional foods like kenkey.

by traders stocking maize with inventory credit increased not only because official reluctance to tackle the internal problems of GFDC, but also as a result of ad hoc interventions by Government that disturbed market fundamentals.

On-farm drying and storage is predominantly in traditional cribs with cobs drying out gradually through natural ventilation. This principle has been extended by the introduction of the narrow crib, which allows for more drying. While Sasakawa Global 2000 (SG 2000) originally subsidised their installation, farmers are now widely adopting the technology at their own expense.

Unmet demand for grain drying facilities
The demand for drying services comes from farmers, poultry farmers and traders (mainly serving the "modern" sector) during period of July to December. There is a significant unexploited market niche for such services, particularly from farmers. This is indicated by: (a) the price gap in July and August – price for new wet maize is reported to be typically only about two thirds that for old dry maize, and: (b) by losses farmers experience during the early harvest period. Farmers in Offuman talk of losing 25% of their grain in this way – much grain goes mouldy even when stored with insecticide in narrow cribs, but often farmers have insufficient storage space in cribs and the cobs are damaged by rain when piled on the ground. While such loss estimates are notoriously inexact, they show that farmers are experiencing a serious problem, which could be tackled by suitably placed and trusted drying services. The problem increases as farmers intensify their production and have to handle larger quantities of grain.

The volume handled by GFDC in 1995/96 – 20,555 tonnes as shown in Table 4, indicates a portion of the market potential for mechanical drying in Ghana. Doubtless, much larger quantities of grain would have been dried by GFDC if it had (a) a clean reputation with farmers and traders – in practice small farmers or farmer groups have never been willing to use its services; and (b) the confidence of the banking sector – in practice only ADB was willing to lend against stocks stored by GFDC. The grain drying and storage facilities of GFDC (list attached as Appendix 3) are currently not operational for reasons indicated above[28].

[28] The exit of engineers from GFDC means its capacity to rehabilitate and maintain its facilities may be in doubt.

TABLE 4: TONNES OF MAIZE PROCESSED AT GFDC SITES IN ASHANTI AND BRONG-A

	1988/89	1989/90	1990/91	1991/92*	1992/93	1993/94	1994/95	199
Ashanti Region								
Aframso	1,607	635	447		357			
Mampong	1,768	447	575			452	716	
Sekodumase	1,748	1,399	1,429	449	879	1,225	1,137	
Abofour	2,381	1,093	726	16	403	1,031	1,808	
Ejura Farms			244					
Agogo						139	510	
Kumasi								
Total	7,504	3,574	3,421	465	1,639	2,847	4,171	
Sunyani Area								
Sunyani	1,432	1,215	1,278	267	941	709	2,121	
Berekum	1,738	2,327	1,109	493	260	1,210	577	
Badu			1,914	392	935	840	1,192	
Goaso			531					
Total	3,170	3,542	4,832	1,152	2,136	2,759	3,890	
Nkoranza Area								
Nkoranza	2,540	2,558	2,609	888	1,526	739	3,542	
Techiman	1,136	1,613	1,559	95	811	282	2,386	
Wenchi	1,215	1,055	491	77	142	237	1,088	
Kintampo	72	795	879	99	406	552	1,816	
Total	4,963	6,021	5,538	1,159	2,885	1,810	8,832	
Overall total	**15,637**	**13,137**	**13,791**	**2,776**	**6,660**	**7,416**	**16,893**	

* Note: Nkoranza Area figures for 1991/92 may be under-recorded n/a = not available

Source: Coulter et al, 1997.

Volumes of private storage and drying facilities are also unknown – most of these belong to poultry farmers, especially in Brong Ahafo and Ashanti, some of whom store for 5 months or more to take advantage of seasonal price fluctuations. These are mostly small Alvan Blanch batch dryers of 1 to 3 tonne capacity. There are at least 5 operational in Kumasi, 2 in Nkoranza, 1 at Techiman and 1 at Sunyani. There are a few continuous flow dryers: one operational at Ejura Farms but another at Kopon Farms, which is out of operation.

Small-scale drying proves viable in transition zone

Small-scale drying operations using locally fabricated equipment are proving financially viable and competitive with GFDC charge rates. This is evident from a visit to a private drier, with cleaner, belonging to Diram Enterprises (belonging to an ex-GFDC engineer) at Techiman. With a 6 tonne capacity batch drier, he processed 1,250 tonnes of maize in 1998/99 and about 1,600 tonnes in 1999/2000 (25%-30% being only cleaning). The costs of the operation show that it is competitive with GFDC and if somewhat more costly than operations in developed countries (due to the very small scale of operation), not hopelessly out of line. Further commercial development will gradually bring costs down to international levels – but the fact that costs are high illustrates an area where some infant industry protection is justified. The economics of a similar operation planned for Offuman are analysed in Appendix 2.

But GFDC 'heritage' is a hindrance

Unfortunately, there is among farmers a general distrust of mechanical drying facilities, associated with their experience of GFDC[29], and this has adversely affected new operators entering the business – the experience of operators in and around Techiman suggests that only the most astute operators are successfully overcoming this problem. While lack of trust is widely attributed to malpractice, it is also partly due to the lack of transparency engendered by the use of continuous dryers and larger capacity batch dryers. When small customers bring maize to be dried, it has to be bulked up into an economic load, so they can't see how much they are loosing through drying and cleaning. In contrast small-scale batch dryers can be operated so as to give the farmer complete confidence – they can see their own grain dried in a batch, and see it weighed before and after.

These developments point to a significant potential for private drying and associated storage services of the kind being supplied by Diram Enterprises at Techiman. They show that drying operations can be viable if dryers are established by well-trusted entrepreneurs close to the producers, using small-scale batch technologies, or depending upon performance, using semi-continuous technology of the kind to be shortly tested by Mr Gyabaah at Abofour. Such driers will need to dry about 500 tonnes of maize per annum to break even, but for comfort they should be established in places where the entrepreneur is confident of getting 800 tonne pa and upwards. One such place is Offuman, where TechnoServe is considering financing a local entrepreneur to build a drier – this could serve as a model for the Maize Belt as a whole.

[29] The poor image of GFDC among depositors and bankers will prove to be a much more significant liability than anticipated as the new private operators become more established.

The development of storage services will depend largely on the trust which the entrepreneur enjoys with the local business and farming community. Exceptional individuals may engender this trust quickly, but in most cases lack of trust will be a continuing difficulty, unless some institutional mechanism can be put in place to regulate warehouses, and insure depositors, and their financiers against fraud or malpractice.

Disturbing market fundamentals impedes private drying/storage service provision
It has to be mentioned that ad hoc imports, which depressed prices in the 1997/98 and 1998/99 seasons discouraged the development of private drying and storage infrastructure and affected demand for such services by farmers. For example, while 41 groups used inventory credit in 1997/98 season, involving a total of 1,043 tonnes under a programme administered in the Techiman zone by TechnoServe, by 1999/2000, the relevant numbers had dropped to 12 and 290 tonnes. Previously there had been no defaults but in 1998/99 a number of groups sold at poor prices and defaulted on their loans[30]. A private drying and storage operation started in Brong Ahafo in 1997, but has faced considerable difficulties as a result of falling demand for such services. If warehouse receipt finance is to be developed as a means to enhance access to agricultural credit, then it is absolutely critical that the uncertainties created by such ad hoc interventions be avoided.

4.3 Transport

The rural road system is considerably more developed in some areas than in others, and shows significant impact on the availability of vehicles**.** The feeder road system is well developed in the Offuman area of Brong-Ahafo. This has facilitated the entrance of pick ups and trucks to farms, consigning head-loading to a thing of the past with harvested maize being moved from the farm to the house by tractors and trucks. Increased access to transport and associated mechanisation of production is facilitating expansion of area planted and intensification of production. But increased production may worsen drying and storage problems (discussed above) unless these bottlenecks can be reduced.

Hopefully, Government can maintain the feeder road system which has been established. One expert feels that an approach involving the upgrading of tracks and lower cost "spot improvements" would be more sustainable (*pers. comm.* John Hine, Transport and Road Research Laboratory, UK).

4.4 Marketing costs and margins

The high distribution costs and margins depicted in Table 4 imply that even the relatively more efficient average maize producer in the maize belt, with a yield of 2.9 tonnes per ha (see Box 2), loses comparative advantage at the retail level without the benefit of a protective tariff regime. At an average production cost per tonne of $108.39 and retail price of $197.07 (with farmgate prices being 55.5% of consumer prices), the farmer can only compete with imports (at landed cost – Tema of $158.5)

[30] In our definition of "groups", we have excluded a partnership of two nucleus farmers who stored 174 tonnes in 1999/2000.

with some measure of duty protection[31]. However, there are considerable opportunities for reducing distribution costs as suggested below.

TABLE 4: MARKETING COSTS AND MARGINS FOR MAIZE IN GHANA		
	Share of CP (%)	Share of CP (%)
Farmgate price	55.5	55.5
Transport (including on and off loading all carriers)	11.6	
Bagging	3.8	
Storage charges and losses (spillage, pilferage, deterioration)	5.0	30.1
Overheads	1.5	
Capital cost	5.4	
Council and assembly levies	2.8	
Agents commission	2.2	
Wholesalers' margin	6.1	14.4
Retailers' margin	6.1	
Consumer price	100.0	100.0
Source: World Bank working paper on maize, 1998		

- As we observed in the Techiman District, improving the rural road network does not only improve access to cargo transport facilities between markets but also makes more readily available to farmers haulage services for transporting produce from farms to primary assembly points or storage sites near their houses.
- It may be possible to reduce 'bagging' costs if the modern sector share of the maize trade involving weight standards expands, thereby reducing intermediary links in the marketing chain as well as associated fees/commissions.
- Improved access to drying and storage services will minimise losses, while creating a competitive grain warehousing industry in the surplus producing zone will reduce storage losses. Similarly, cost of trade finance can be reduced if arrangements that make maize inventory secure collateral are put in place (these issues are discussed further below).
- Costs and losses may also be reduced if District Assemblies provide cover from rain and secure storage facilities at the main public markets. Despite the high levies imposed by these assemblies on maize traders[32], the markets lack basic produce handling and storage facilities, and hard well-drained surfaces. Some assemblies impose both 'export' and 'import' levies on each bag of maize brought into the market and taken out, but if the situation at Techiman market is anything to go by, there is lack of corresponding investment in market improvement.

[31] The difference between the local **retail** price and the imported **landed** price is 24% of the latter. Wholesale and retail margins on the imported product would greatly reduce this difference, but some measure of duty protection might still be needed. Less productive farmers with yields of 1.5 tonnes per ha would be more vulnerable to such competition.

[32] Levies by district assemblies total $5.47 per tonne of maize.

Market information is critical to competitive trade, but is woefully lacking in reliability. We observed lack of supervision and quality control of data collection system and lack of focus (with a large number of markets and commodities being covered). Lack of standard weight measures also made price data interpretation difficult, especially for farmers whose idea of a bag differed from those used by MOFA officials.

5. Summary of emerging issues and recommended actions

Ghana can be described as a low-yield, high-cost maize producer. Factors contribution to this situation include low rates of utilisation of productivity-enhancing inputs like high-yielding seed maize varieties and fertiliser. Lack of drying and storage facilities increase post-harvest losses, raise distribution costs and create problems of supply and quality uncertainty that discourage industrial utilisation of maize on a significant scale. Distribution costs are increased further by a marketing network dominated by a large army of under-capitalised traders using variable weight and quality standards which impede the development of efficient trade by description (rather than by sight). Consequently, local maize production is only competitive in the face of high tariffs. This in part explains why production of yellow maize, which is less protected than the white maize (because tariffs tend to be waived by MOFA), has not really picked up in the country.

The potential to turn this situation around, and quickly too, clearly exist. There exists technical capacity to develop high yielding seed maize, and private distribution systems for agricultural inputs (especially for fertiliser and seed) has been developing despite disturbances arising from ad hoc interventions by Government. Production is becoming increasingly concentrated in the 'maize belt' where such trends as growing intensification of production, awareness of marginal returns to use of fertiliser, and evolving cash-rent tenure arrangements favour rising productivity. Private drying and storage operations are emerging, providing services that the moribund GFDC strategically well-placed to offer. A modern maize trade sector is also emerging, with the potential to bring about improvements in the trade while demand from industrial users is growing and will do so even faster if supply chain and quality problems are reduced.

Government can exploit these positive developments and bring about sustainable improvement in the maize sector by pursuing the following actions:

1. Creating a conducive policy environment through:
    - Avoiding ad hoc interventions in input and output markets. Prices should be determined by supply and demand, the only exception being where a national emergency has been declared by vote in parliament.
    - Protection of domestic industries should be confined to the use of tariffs which should be clearly justified on the grounds of (a) the need to compensate for subsidies in exporting countries, or (b) infant-industry arguments. In the latter case the country should have a coherent and time-bound plan to overcome the situation giving rise to the need for protection. There should be no discretionary import permits, and no quantitative restrictions.
    - Trade (sub-regional and international) should be used as a tool to ensure food security in the event of deficits. Unlike rice, price rather than quality

competition is the key issue in imports, and as such it is feasible to regulate imports mainly by means of tariffication and therefore there is no need for discretionary use of permits.

- Vigorously pursue macro-economic stability since input prices tend to reflect more of currency depreciation than absence of a competitive market structure, and high borrowing cost is due to a large extent to fiscal/monetary policy slippage.

2. Should concentrate on the 'maize belt' in the provision of public infrastructure – roads, ports and telecommunications in support of the development of the sector.

3. Subsidisation or public distribution of fertiliser is not sustainable and should be avoided. Government should investigate the financial and economic feasibility of local blending of fertiliser and encourage private operators to invest in this.

4. Encourage NGOs assisting farmers and other players to develop sustainable self-help organisations and institutions to improve access to markets and other agricultural services. In the specific case of developing group-based inventory credit schemes, the NGOs should be encouraged to facilitate access of groups to private drying and storage facilities as group ownership and management of such service provision often entail direct or indirect subsidies that can not be sustained. Government itself should avoid direct involvement in promoting such organisations, as this will inevitably lead to their politicisation and undermine effectiveness.

5. Priority should be placed on a stronger and more proficient policy formulation, monitoring and evaluation and information function. With regard to the latter, there is a need for basic information required for decision-making by farmers, agribusiness and others. Particularly valuable would be (a) a comprehensive annual bulletin, covering production, imports and exports, and domestic usage of crops, (b) more accurate crop forecasts, (c) a better targeted and more timely market information system, which meets the need of market participants. Research should be carried out to establish exactly what sort of information it is worth collecting and distributing. The FAO could be asked to contribute its considerable technical expertise in this area.

6. Government should create the regulatory, policy and institutional environment that will promote the confidence of depositors and banks financing against stocks stored in "public warehouses" (that is those that are open to all-comers). This will include:

- Urgently pursuing the restructuring and privatisation of GFDC so that its facilities can be used efficiently for the benefit of the country.
- Instituting a strict regulatory service for licensing and inspection of warehouses – and ensuring that the depositors' and lenders' interests are covered against fraud. Such a system will ensure that the facilities of small private warehouse operators located in the surplus producing regions are well-run and can be used by farmers and traders to access inventory credit. It will also encourage increased private investment in grain storage facilities in the interior of the country and thereby ease storage constraints.

APPENDIX 2: ECONOMICS OF DRYING AT OFFUMAN USING BATCH-DRYING TECHNOLOGY

Assumptions

			In US $
Rate of exchange at time of study (c/US$)	3,045		
Drier capacity (tonnes/batch)	3.5		
Drier capacity (tonnes/day)	10.5		
Capital costs (c '000)	60,000		19,704
Weighted average cost of capital - in real terms	15%		
Throughput in first year	420	tonnes dried	
Average drying percentage	6	%	
Revenue/tonne per % reduction in m/c (c '000)	7.69		2.53
Revenue/tonne (c '000)	46.14		15.15
Drying revenue in first year (c '000)	19,379		6,364

		Project budget in '000 cedis - year 1	**Cost in '000 cedis per tonne dried**	**Project budget in US $ - year 1**	**Cost in US$ per tonne dried**	**Costs as percent of revenue**
Operating costs (assumed to be variable)						
Fuel		4,272	10.17	1,403	3.34	22%
Lubricants		63	0.15	21	0.05	0%
Maintenance		600	1.43	197	0.47	3%
Salaries		3,240	7.71	1,064	2.53	17%
Electricity		450	1.07	148	0.35	2%
Stationery		180	0.43	59	0.14	1%
Total		8,805	20.96	2,892	6.88	45%
Revenue		19,379	46.14	6,364	15.15	100%
Surplus over operating costs		10,574	25.18	3,473	8.27	
Annuity of capital costs (15% pa, 10 years):						
assuming throughputs in tonnes/annum of:	420	11,955	28.46	3,926	9.35	
	800	11,955	14.94	3,926	4.91	
	1,200	11,955	9.96	3,926	3.27	
Surplus over operating and capital costs:						
assuming throughputs in tonnes/annum of:	420		(3.29)		(1.08)	
	800		10.23		3.36	
	1,200		15.21		5.00	
Breakeven revenue per 1% m/c reduction						
assuming throughputs in tonnes/annum of:	420		8.24		2.71	
	800		5.98		1.97	
	1,200		5.15		1.69	

Source of data used: TechnoServe, Mr Diram, entrepreneur in Offuman