Modelling the Financial Viability of Inventory Credit: *developing a methodology with examples from Ghana and Zambia*

George Day

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1. *Introduction*

1.1 Background

The Natural Resources Institute (NRI) has undertaken research on the practical implications of grain market liberalisation over a number of years. A major theme of this work has been the importance of improved methods of trader financing to promote the efficient operation of grain markets to the benefit of producers and consumers alike.

Within this context, NRI has undertaken work in both Ghana and Zambia to examine the potential for the use of inventory credit in grain trade financing. Inventory credit essentially involves lending for crop purchases secured against stocks which are held as collateral in a secure storage place to the mutual satisfaction of lender and borrower. Among the advantages of inventory credit for agricultural financing are:

- it reduces the risk of lending to private traders
- it can assist in overcoming financing constraints associated with newly liberalised markets
- it may promote competition in agricultural markets, and reduce the likelihood of socially undesirable outcomes associated with thin markets dominated by a small number of powerful participants
- it may contribute to reduced inter-seasonal price instability.

Through the ODA-funded project 'Trader Financing in Ghana' (TO 534), NRI has been working directly with banks, traders and officials to promote the use of inventory credit for maize in Ghana. In Zambia, NRI has undertaken research to assess the scope for inventory credit.

1.2 Objectives

This piece of work has been undertaken in order to develop a simple methodology for assessing the financial viability of inventory credit. The method used is the development of a simple spreadsheet model which may be used by promoters of inventory credit, traders, bankers and other interested parties. The model is developed based on data for markets in Ghana and Zambia, using certain simplified assumptions in line with data currently available to NRI. Given the lack of field verification of these assumptions, the results of the analysis should be interpreted with caution. The author plans to update the analysis of Ghanaian data following a visit to Ghana in late 1996, and thereby produce a more accurate picture of the prospective returns to storage.

2. *Methodology*

2.1 Variables

The methodology used was the development of a simple spreadsheet using historical wholesale price data combined with historical price indices to calculate the real returns to interseasonal storage of agricultural commodities. The spreadsheet processes data relating to a number of variables in order to calculate financial viability. These variables are outlined below:

- **Commodity procurement / transactions costs** - the costs of purchasing a load of the commodity and placing it in a secure storage facility. This includes costs of rebagging, loading, transportation from point of purchase to point of storage (& vice versa), drying and cleaning operations prior to storage. All of these along with the wholesale price (taken from historical data) represent 'up-front' capital costs.
- **Monthly storage costs** - costs which build up on a monthly basis. These include warehouse rentals, management fees due to storage managers and any treatment costs (fumigation etc).
- **Historical and current inflation** - data on historical and current inflation rates for the country under study are required in order to express historical wholesale prices in real terms and calculate returns in real terms.
- **Historical wholesale prices** - data on historical prices is required, preferably over a period of a number of years. This data forms the basic raw material for the model.
- **Real interest rate** - (i.e. the bank interest rate for agricultural loans less the rate of inflation) this represents the real cost of the capital tied up in the commodity under storage.
- **Weight loss** - assumptions about the amount of weight loss experienced during storage. This will include a component for weight loss due to drying (which may vary according to the seasonal timing of purchase) and a further component for weight loss due to spoilage etc while in storage.
- **Bank charges** - a percentage rate to cover bank financing charges on the credit transaction
- **Equity requirement** - an assumption regarding the minimum proportion of equity investment required to unlock inventory financing from the banks. A figure of 25% for this requirement is assumed.

2.2 Calculation of Returns

Returns are calculated for each month of purchase according to the length of time the stock is held before resale at the wholesale price. All figures for returns are expressed in real terms, i.e excluding the effects of general price inflation.

Returns are calculated in terms of:

- returns on capital employed (i.e. equity and bank loans)
- returns to equity

2.3 Assumptions

The assumptions implicit in the model are best explained by elucidating the equations used in the spreadsheet:

Return on capital employed (ROCE) is calculated according to the following formula, for purchases of the commodity in month i held for a period of x months:

ROCE =

$$\frac{\text{(Total revenue at point of sale) less (Costs of purchase, storage and bank charges)}}{\text{(Costs of purchase, storage and bank charges)}}$$

Expressed in algebraic form as:

$$ROCE = \frac{(A_{(i+x)} * (1 - B)) - (A_i + C + D_x + E)}{A_i + C + D_x + E}$$

where:

A_i	=	real wholesale price in month ***i***.
$A_{(i+x)}$	=	real wholesale price x months after month ***i***.
B	=	weight loss experienced during transit and storage
C	=	costs of procuring commodity, including rebagging, loading, transportation in and out, drying and cleaning.
D_x	=	monthly storage costs for x months, including warehouse rental, management fees and treatment costs.
E	=	bank charges on capital borrowed from bank (i.e proportion of purchase price lent)

Implicit assumptions in the formula:

- Bank charges are counted as part of capital employed i.e. as if they were paid as part of the 'upfront' costs of the transaction.
- Transport costs from the point of storage to the point of eventual sale (i.e. at the end of the period of storage) and all storage charges are treated as part of 'upfront' costs of the transaction. This assumption is made for the sake of simplicity and conservatism.
- The returns calculated by this method are not annualised, but merely show the percentage return on capital employed *over the period between purchase and sale of the commodity.*

Returns on equity are calculated according to the following formula:

$$\frac{\text{(Total revenue at sale) less (Costs of purchase, storage, bank charges and interest)}}{\text{Equity invested}}$$

Expressed in algebraic form as:

$$\text{Return on equity} = \frac{(A_{(i+x)} * [1 - B]) - (A_i + C + D_x + E + G_x)}{(F * A_i) + C + D_x + E}$$

where:

F = equity requirement of bank (i.e. proportion of value of commodity required by bank to be equity financed to release loan financing).

G_x = bank interest charged on a loan held for x months.

Implicit assumptions in the formula are:

- The returns calculated by this method are not annualised, but merely show the return on equity over the period between purchase and sale of the commodity, i.e. a period of x months.
- No attempt has been made to include the effects of any taxation measures on the returns on equity.

3. Constructing the Spreadsheet

In order to calculate real returns to capital from storage it is necessary to convert the data on nominal historical prices to real values, based on an appropriate base month. It is important to note that each monthly price is adjusted, because inflation may have a significant effect even over a period of a few months when it is running at high levels

A price index can be constructed using Consumer Price Index data - this may be sourced for most countries from issues of the IMF publication International Financial Statistics, or from statistics issued by government or the central bank in most countries.

Step One:
Choose a base month of the year (e.g. June) and a base year (e.g. 1995). Let the CPI figure for that month = 100. Calculate price index figures for the base month in each of the preceding years covered by the analysis using the ratio of CPI figures for those months obtained from International Financial Statistics For example, if June 1995 is taken as the base month, index figures are then calculated for June in each of the preceding years covered by the analysis. It is then assumed that inflation takes place at a constant rate through the year, in order to calculate monthly price index figures.

For example, to calculate the price index for a month between June 1994 and June 1995, the following

e.g. Monthly price index = A + ([B - A] * C)

where:
A = price index for June 1994
B = price index for June 1995
C = number of months after June 1994

The advantage of an assumption that inflation takes place at a constant rate throughout the year is that it excludes any seasonal effect on the CPI caused by regular interseasonal variations in food prices. In some countries, due to the high weights given to basic food items in the CPI and the large inter-seasonal price variations in staple crops, it is possible that the very price variations which those using inventory credit are trying to take advantage of will exert a significant seasonal influence on the CPI.

Step Two:
Calculate real historical prices expressed as base month currency units for all the historical wholesale price data by using the price indices calculated according to the following formula.

Real historical price = $D_i * (E_i/100)$

where:
D_i = nominal historical price for month i.
E_i = price index for month i.

These wholesale prices represent the real prices at which the commodity may either bought or sold. Essentially it is the difference between the price at the time of purchase and the price at the time of sale which give rise to the returns or losses on capital or equity employed in inventory credit

Step Three.
Apply the formula given above using the real historical price data calculated in steps one and two.

4. *Presentation of Results*

Results can be presented in a tabular format showing the returns to storage of purchases made in each month of the year. An example of this form of presentation is contained in Appendix 1.

e.g.
January Purchases: Returns on Total Capital Employed

	Number of Months Stock Held										
Year	1	2	3	4	5	6	7	8	9	10	11
1992	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%
1993	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%
1994	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%
1995	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%	x%
Ave	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%	x_{av}%

Thus, a table can be prepared for each month of the year, showing returns to storage from holding stocks for varying periods of time. The table is based on historical wholesale prices expressed in real terms. The bottom line shows the average return to storage of stocks of the commodity purchased in that month and held for a specific number of months. The advantage of this method of presenting results is that it illustrates the variability of returns from one year to the next, thus giving a rough illustration of the riskiness of returns. Tables in this format can be prepared to present the returns on total capital employed and the returns on equity.

Results can also be presented in a graphical form for each purchase month. The percentage return on total capital employed is plotted on the Y axis, against the number of months the stock is held on the X axis. Average results for each month are plotted with a solid line, while the results for individual years are plotted with dotted lines. The solid line therefore maps for each month the returns which could be expected in an 'average' year if the commodity were purchased in that particular month. The degree of dispersal of the dotted lines gives an indication of the extent to which returns vary from year to year, and therefore indicate the price riskiness of an investment in purchasing the commodity during that month. Figure 1 shows an example of this method of presentation for January purchases of maize in Techiman - further plots, and a full tabular presentation of results for purchases of maize in Techiman under specified assumptions are contained in Appendix 1.

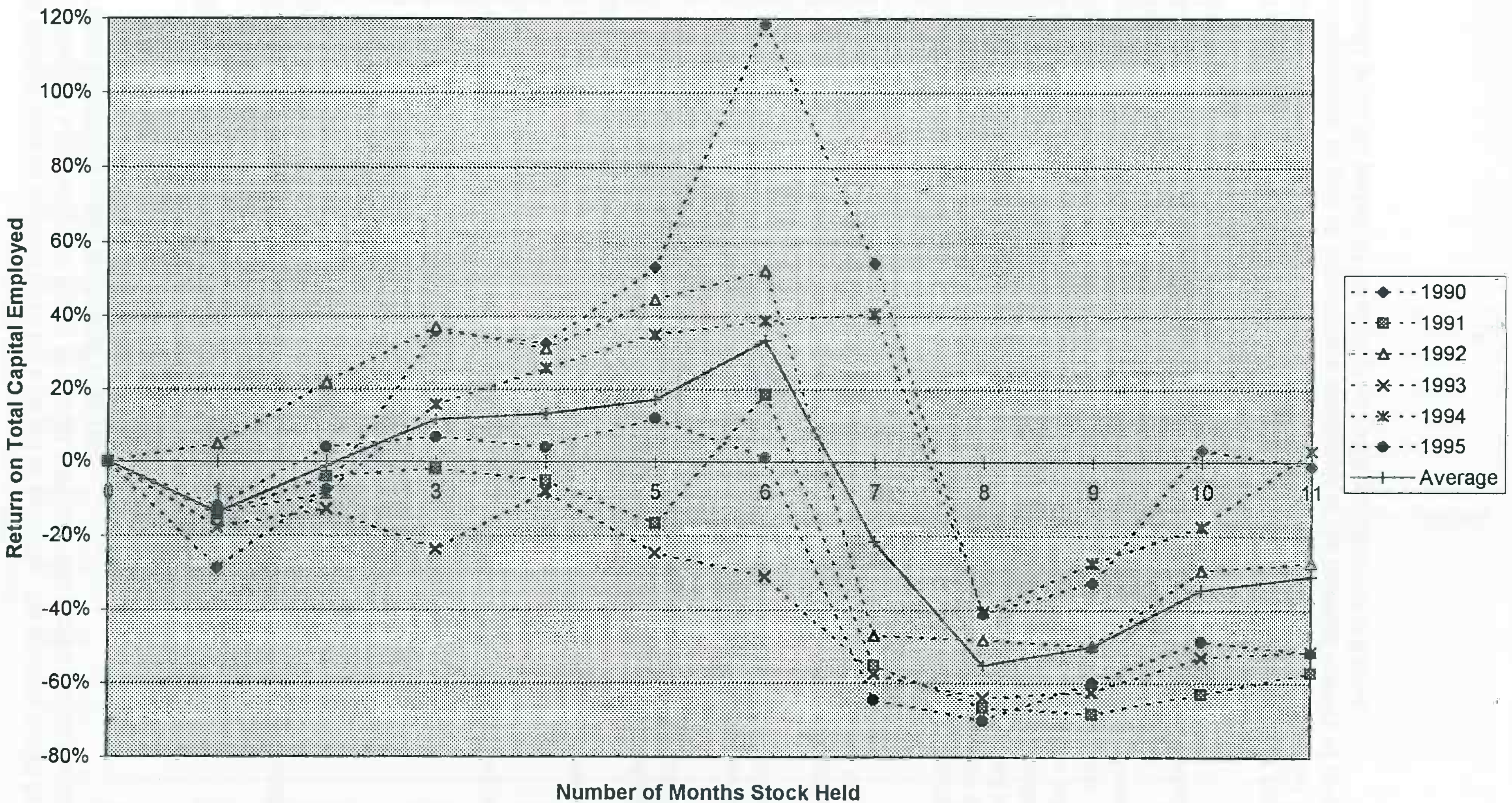
Results for each commodity/location can also be summarised on a single graph showing the average returns by month of sale with a plot for each month of purchase. Thus, there are twelve graph lines (one for each month of purchase), with the month of sale plotted on the X axis. The plot lines 'tail away' from the month of purchase on the X axis, indicating the pattern of returns over time as months pass from the time of purchase. Figures 5 - 11 show examples of this method of presentation, for purchases of maize in Tamale, Techiman and Kabwe under the assumptions indicated on the graphs.

4.1 Interpreting Results

It is important to be able to interpret results correctly in order to make sound investment decisions. The investor needs to compare the real returns on equity with what he/she would consider a minimum acceptable real return on equity. The minimum acceptable return on equity would typically be higher than the real interest rate for bank loans, due to higher risk. This may be particularly so in high inflation economies where price risks are greater, or where agricultural markets are characterised by price instability.

An example may help to illustrate the sort of calculation. If the money interest rate for bank loans were 50% and inflation were 40%, the real interest rate would be 10%. An investor in a high inflation economy may consider that a minimum acceptable real return would be 20%.

Figure 1: JANUARY PURCHASES:
Viability of Inventory Credit for Maize in Techiman



Assumptions:
Weight loss 2% - 10%
Monthly storage charges @
C 5,000 /t/month

inventory credit viability

If storage were to be undertaken for a period of 6 months, the investor would be looking for a real return on equity of at least 10% over that period (i.e. an annualised return of 20%) to justify investment in storage.

5. *Examples from Ghana and Zambia*

The spreadsheet model was constructed to analyse the viability of inventory credit for maize in three locations:

- Techiman, Ghana
- Tamale, Ghana
- Kabwe, Zambia

Figures 2 - 4 show the seasonal pattern of real maize prices for these locations over a number of years.

For the Ghanaian examples, the model was run in each case with three different sets of assumptions relating to the monthly storage costs:

- a low cost scenario with storage costs of C 2000 /tonne/month corresponding approximately to the costs of storing maize through the Ghana Food Distribution Corporation (GFDC)
- a high cost scenario with storage costs of C 10,000 /tonne/month corresponding approximately to the costs at the end of 1995 of storing maize with the storage management company SGS (Ghana) Ltd.
- a middle level scenario with storage costs of C 5,000 /tonne/month; Appendix 1 contains a full tabular and graphic presentation of results for this scenario in Techiman.

Furthermore, differing assumptions were made regarding weight loss assumptions reflecting local climatic conditions and the likely effect on the moisture content of maize being marketed. In Tamale it was assumed that a 2% weight loss would result following storage, whereas in Techiman it was assumed that weight losses would vary between 2% and 10% depending on the month of purchase. This assumption reflects the fact that much maize marketed immediately after harvest is high in moisture content. Other assumptions reflect NRI knowledge of local costs and conditions in Ghana - although it should be stressed that these examples present indicative calculations only. They could be validated in the field relatively simply by updating the assumptions used.

For the Zambian example it was not possible to obtain and validate cost data from the field. The model was run using assumptions about costs based on international comparisons, to give an approximate assessment of the potential viability of inventory credit given the pattern of seasonal price variations observed in Kabwe.

Figure 2: Wholesale Maize Prices, Techiman, Ghana (1990-95) in June 1995 cedis

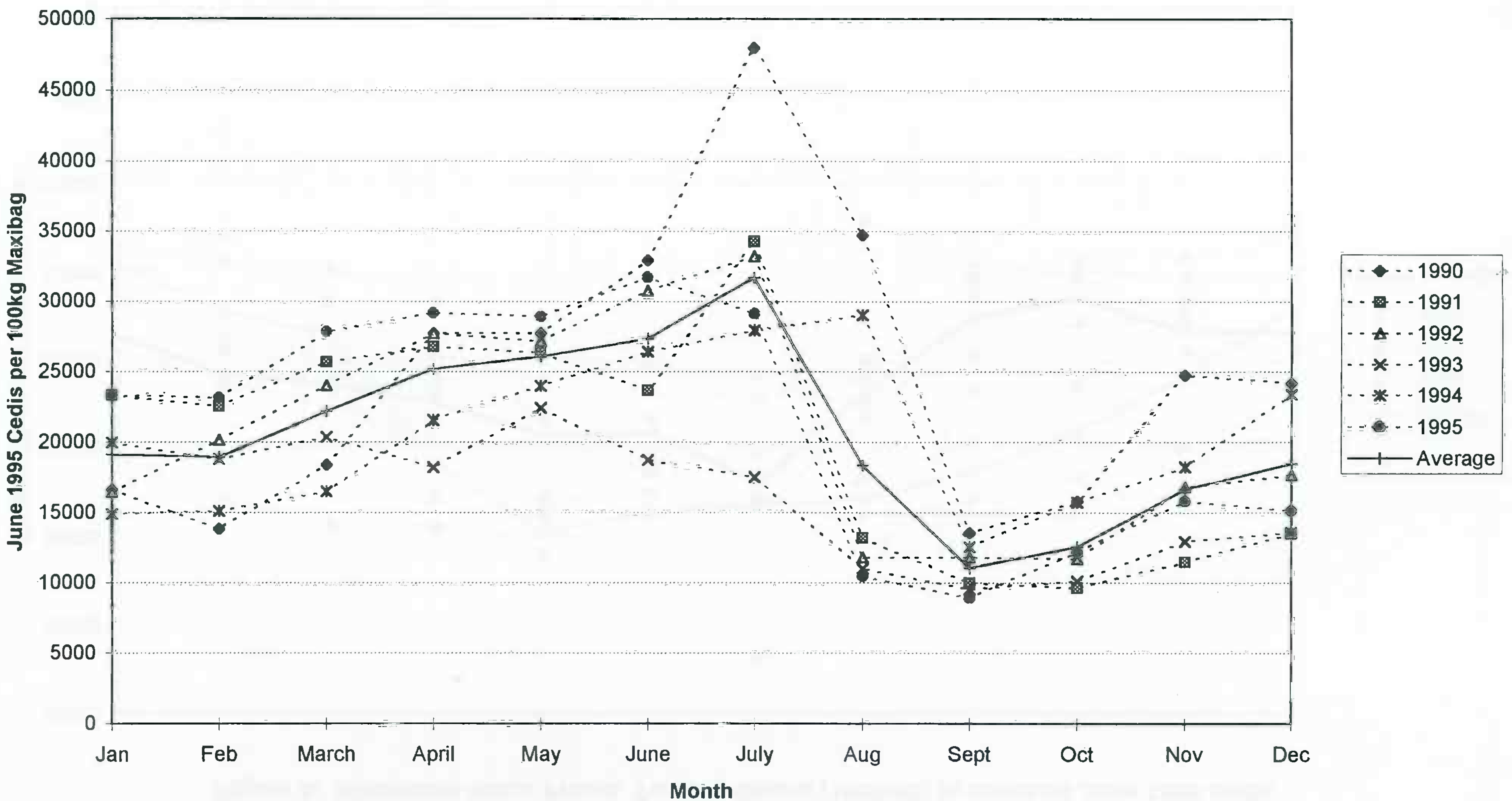
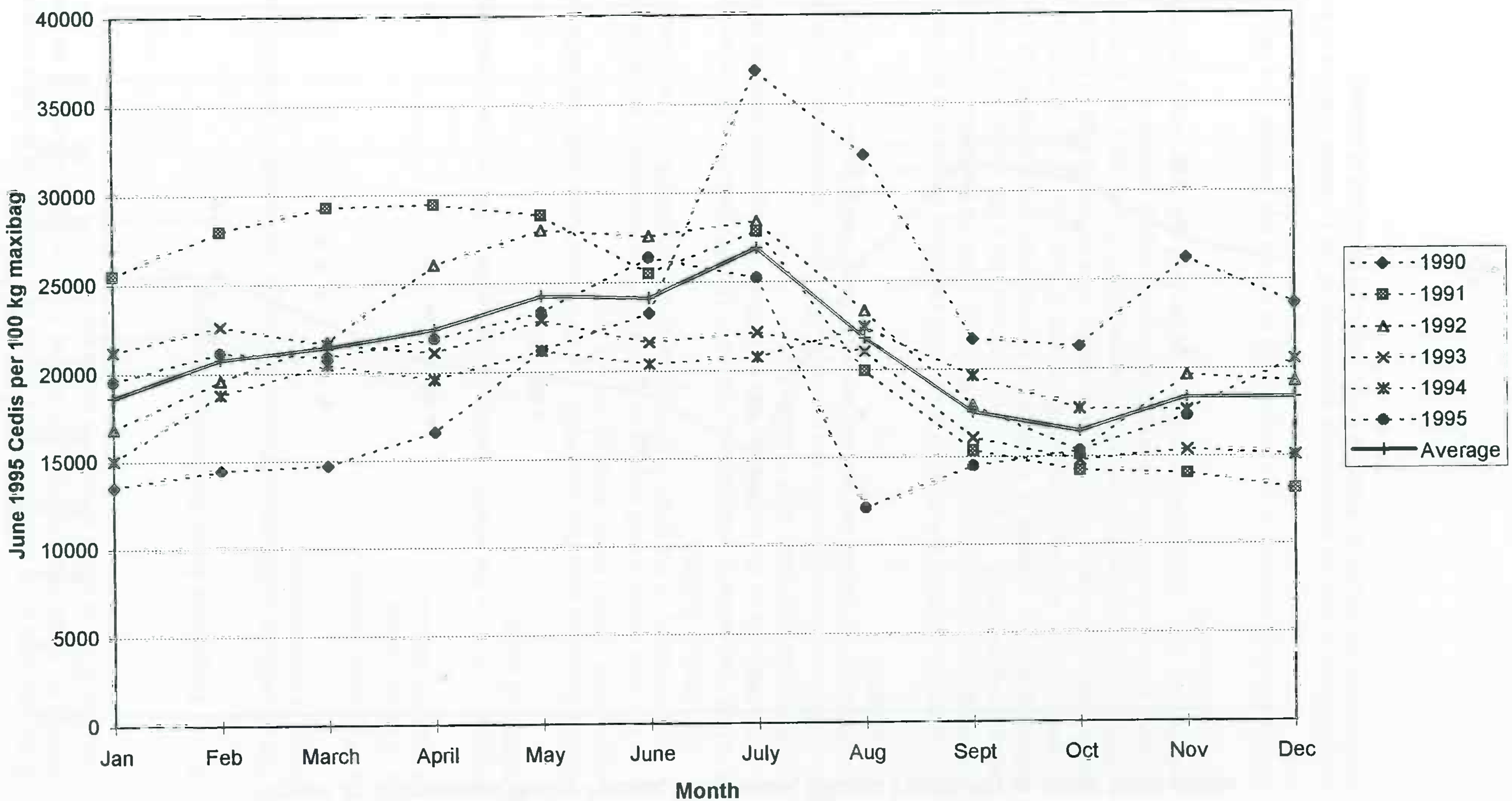


Figure 3: Wholesale Maize Prices, Tamale, Ghana (1990-95) in constant June 1995 cedis



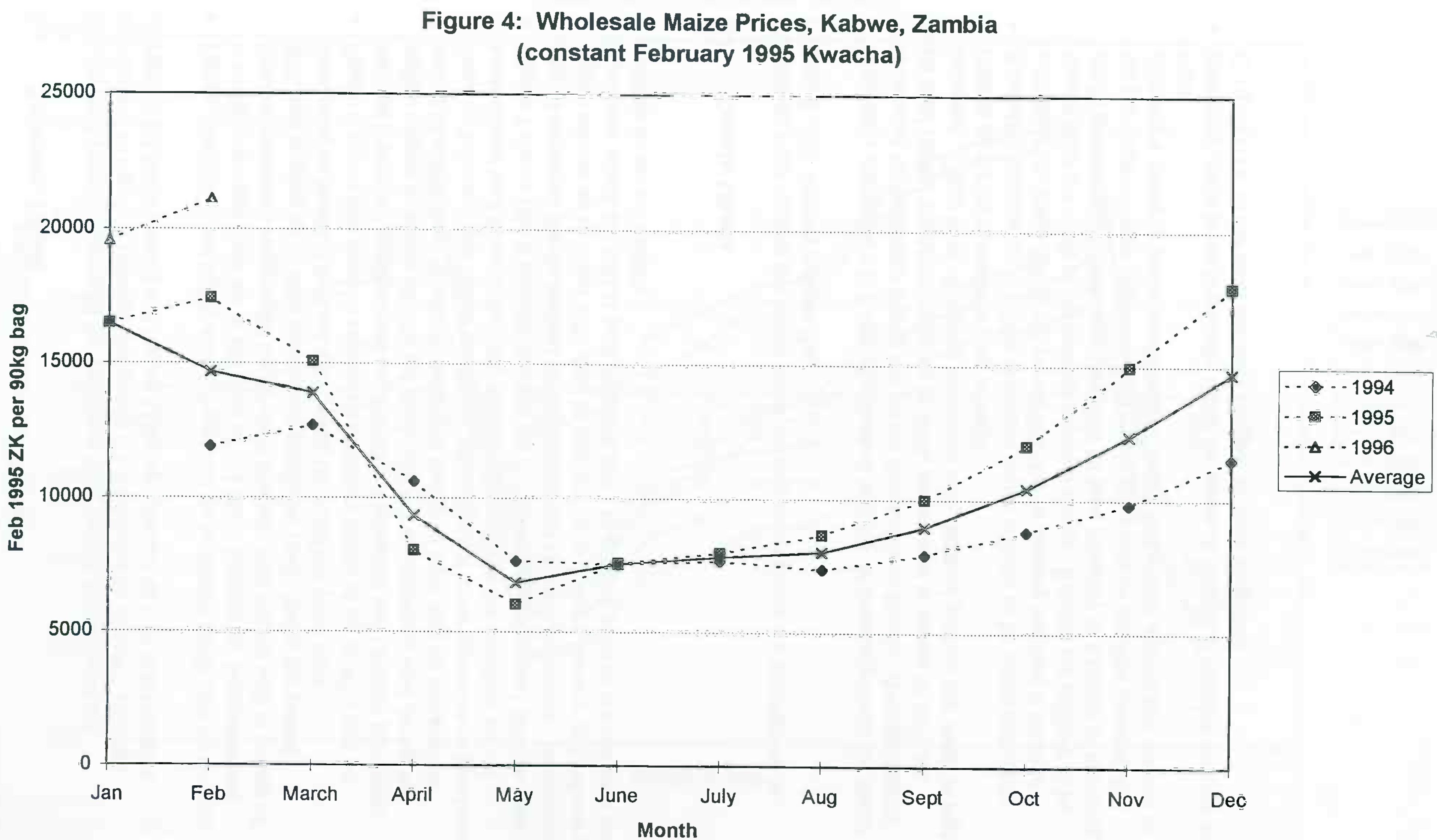


Figure 4: Wholesale Maize Prices, Kabwe, Zambia
(constant February 1995 Kwacha)
25000
20000
15000
10000
5000
0
Feb 1995 ZK per 90kg bag
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
1994
1995
1996
Average

5.1 Techiman, Ghana

Results from running the model for Techiman with varying assumptions are summarised in Figure 5 (storage charges @ C2,000/t/month), Figure 6 (storage charges @ C5,000/t/month) and Figure 7 (storage charges @ C10,000/t/month).

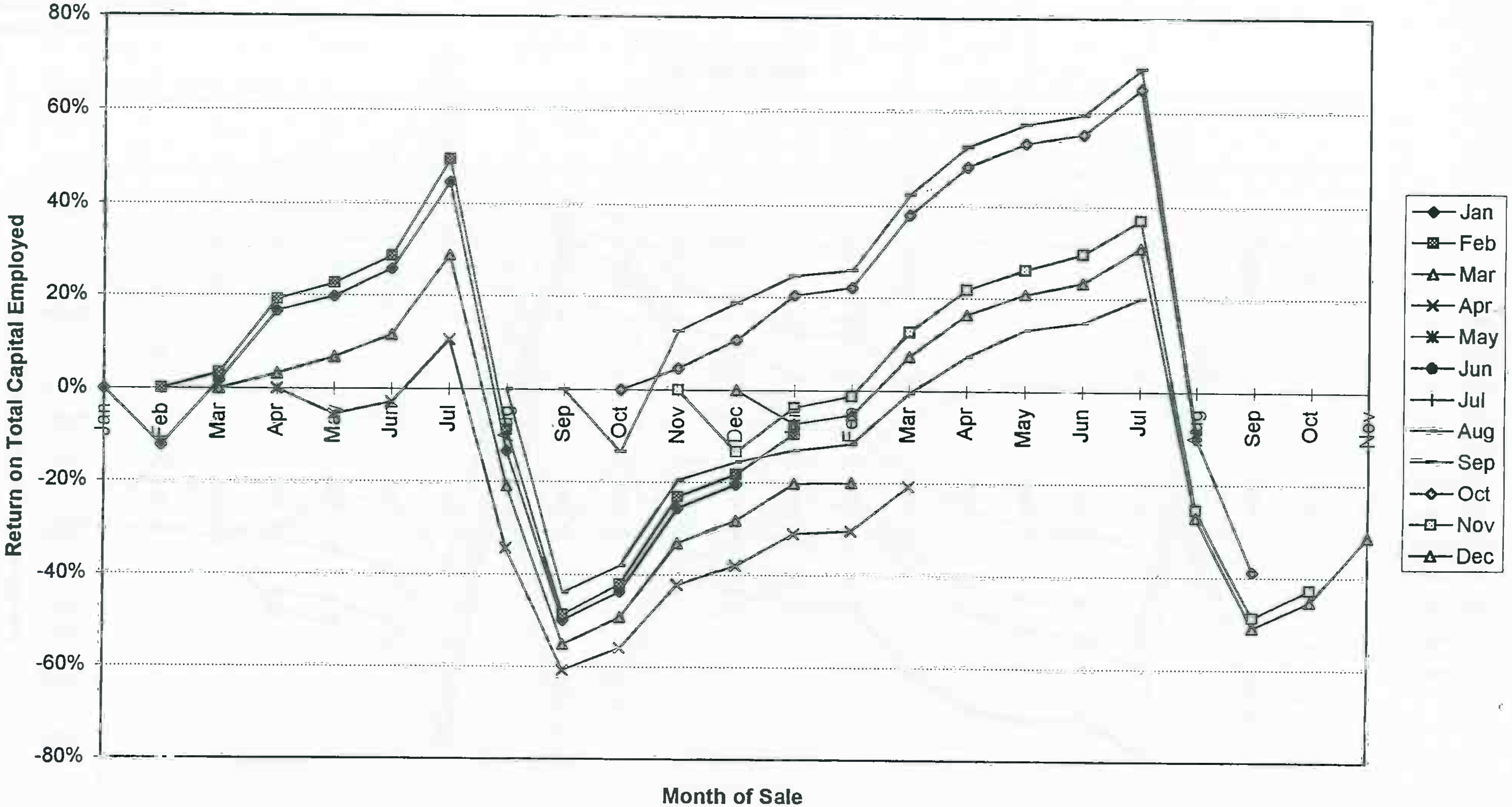
- Figure 5 indicates that highly attractive returns on inventory credit may be realised if monthly storage costs are at the level of C 2,000. Returns for September and October purchases range up to the 60-70% bracket, with returns well in excess of 20% and ranging up to 40% possible on purchases made during the period November to March if they are sold during the June/July price peak.
- Figure 6 shows that clearcut returns on inventory credit of up to 40% may be realised if monthly storage costs are C 5,000. September and October purchases realise returns in excess of 20% for stock which is subsequently sold during the period March to July. Similarly, returns in excess of 20% may be obtained for January, February and March purchases, which though more expensive to purchase, have shorter lead times to the very marked price peak in the June/July period.
- Figure 7 shows that if monthly charges are C 10,000, returns around 10% on total capital employed maybe realised for September and October purchases. Somewhat higher returns up to about 20% may be realised for purchases January and February purchases which are sold at peak prices in July. In general, returns are marginal and unlikely to attract traders.

5.2 Tamale, Ghana

The results from running the model under varying assumptions are summarised in Figures 8 - 10. Results indicate that:

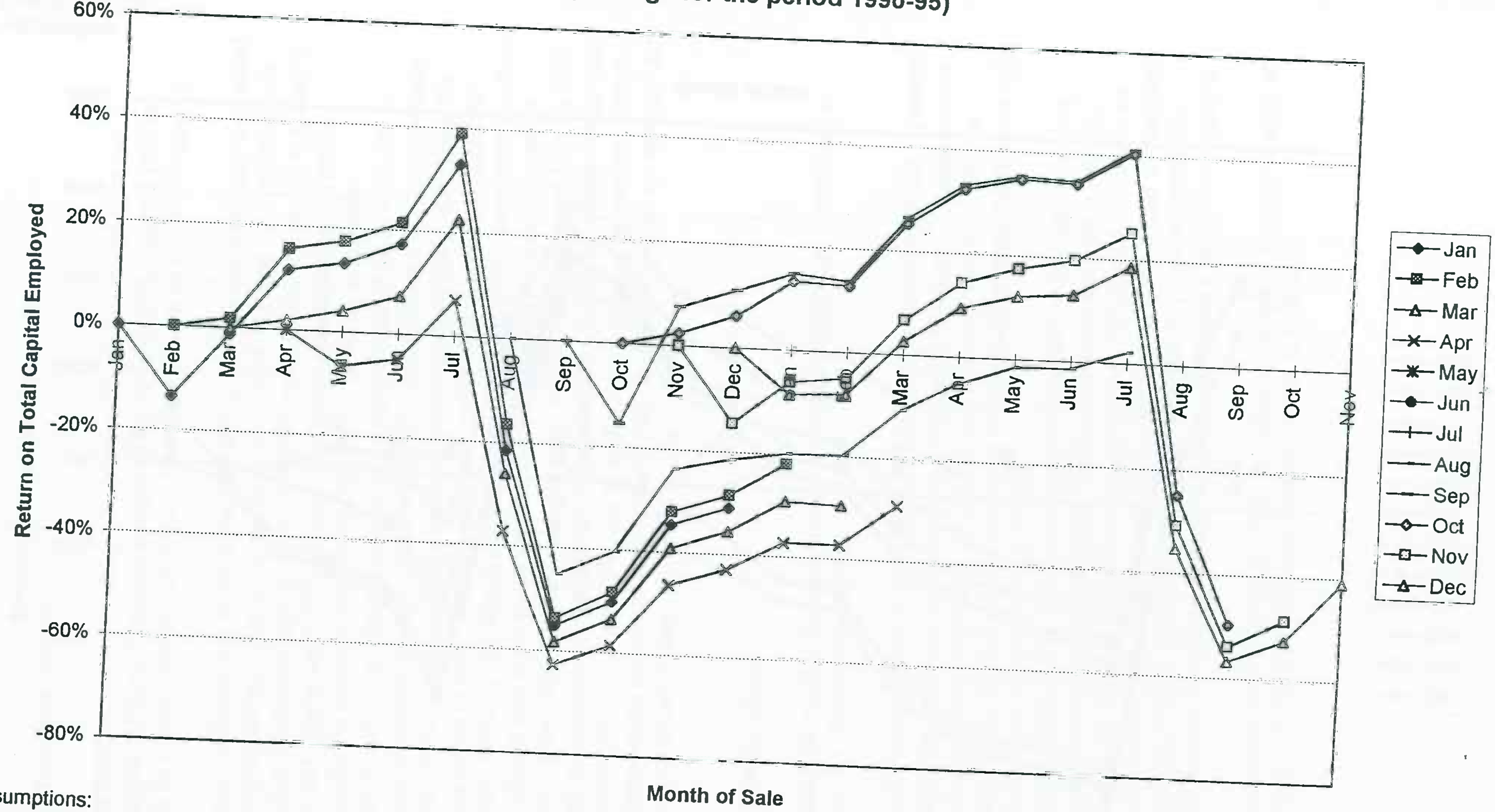
- If monthly charges are C 2,000, the financial viability of inventory credit for maize is clearcut for purchases during the period September to March. Average returns on total capital employed range up to 30%, and returns in excess of 10% are common. These level of returns, combined with financial gearing can result in high returns on equity invested in crop storage.
- If monthly charges are C 5,000, inventory credit is likely to be viable providing purchases are made during the period October to January and care is taken to ensure sales are made at the optimal seasonal timing. Returns are unlikely to be great, and inventory credit may therefore be seen primarily as a means of financing the purchase of larger quantities than would otherwise be possible (potentially allowing a trader to realise economies of scale), rather than a profitable venture in itself.
- Inventory credit is not financially viable for maize in Tamale, if monthly charges are C 10,000 (i.e. at the level currently charged by SGS in Ghana)

Figure 5: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Techiman, Ghana (Average for the period 1990-95)



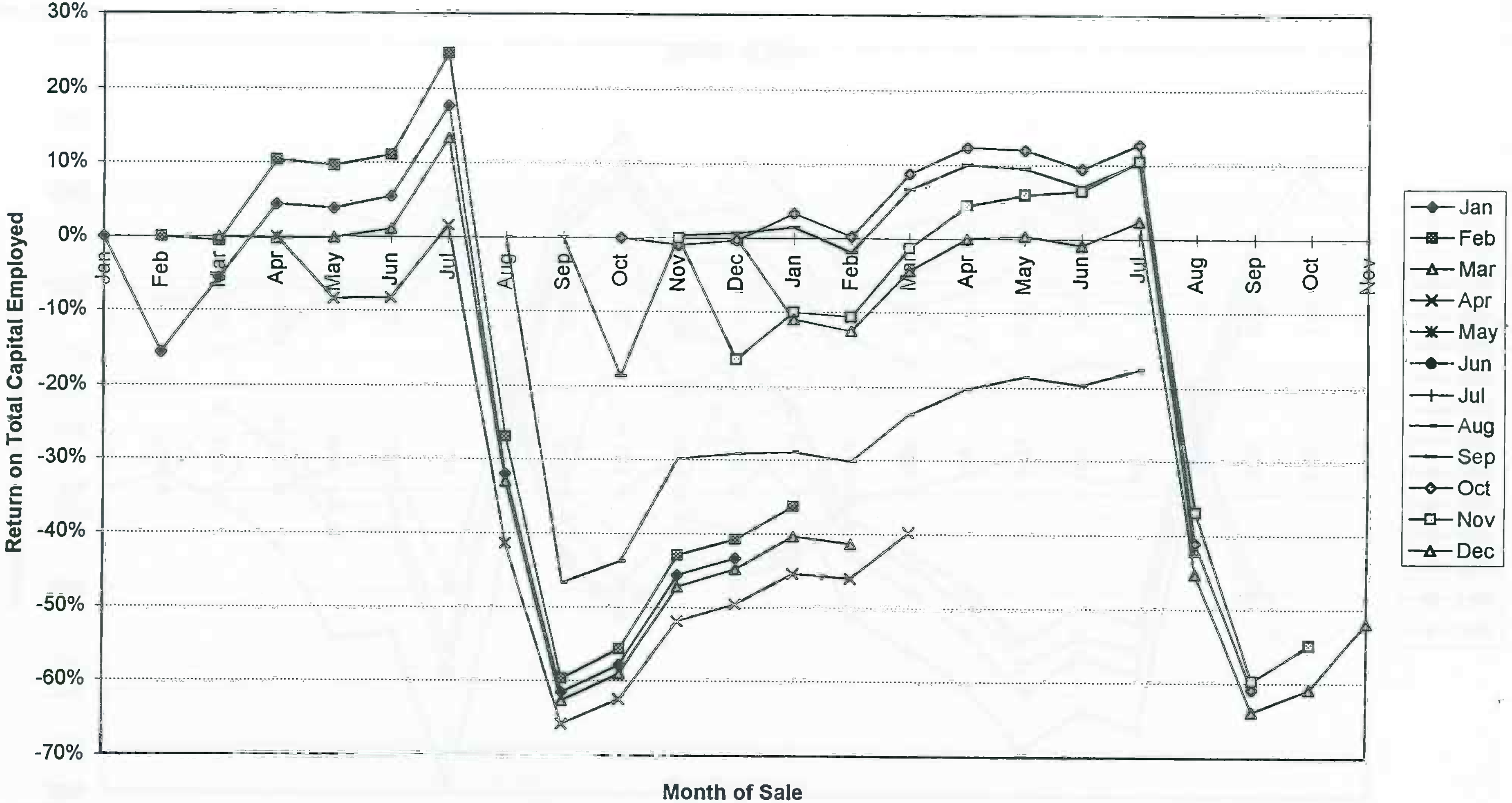
Assumptions:
Weight loss 2% - 10%
GFDC Monthly Charge Rates
(C 2,000 /t/month)

Figure 6: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Techiman, Ghana (Average for the period 1990-95)



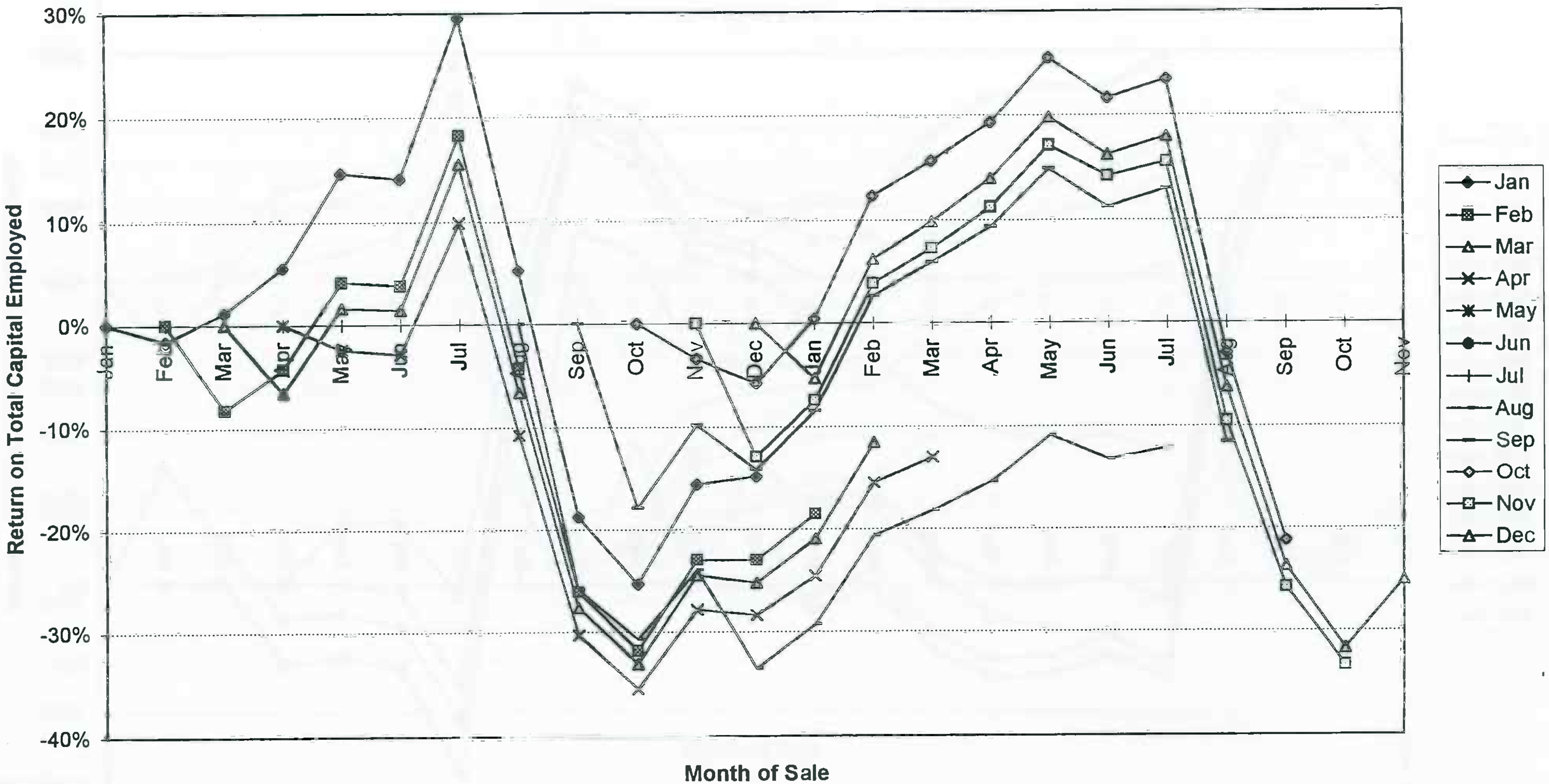
Assumptions:
Weight loss 2% - 10%
Monthly Charge Rates
(C 5,000 /t/month)

Figure 7: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Techiman, Ghana (Average for the period 1990-95)



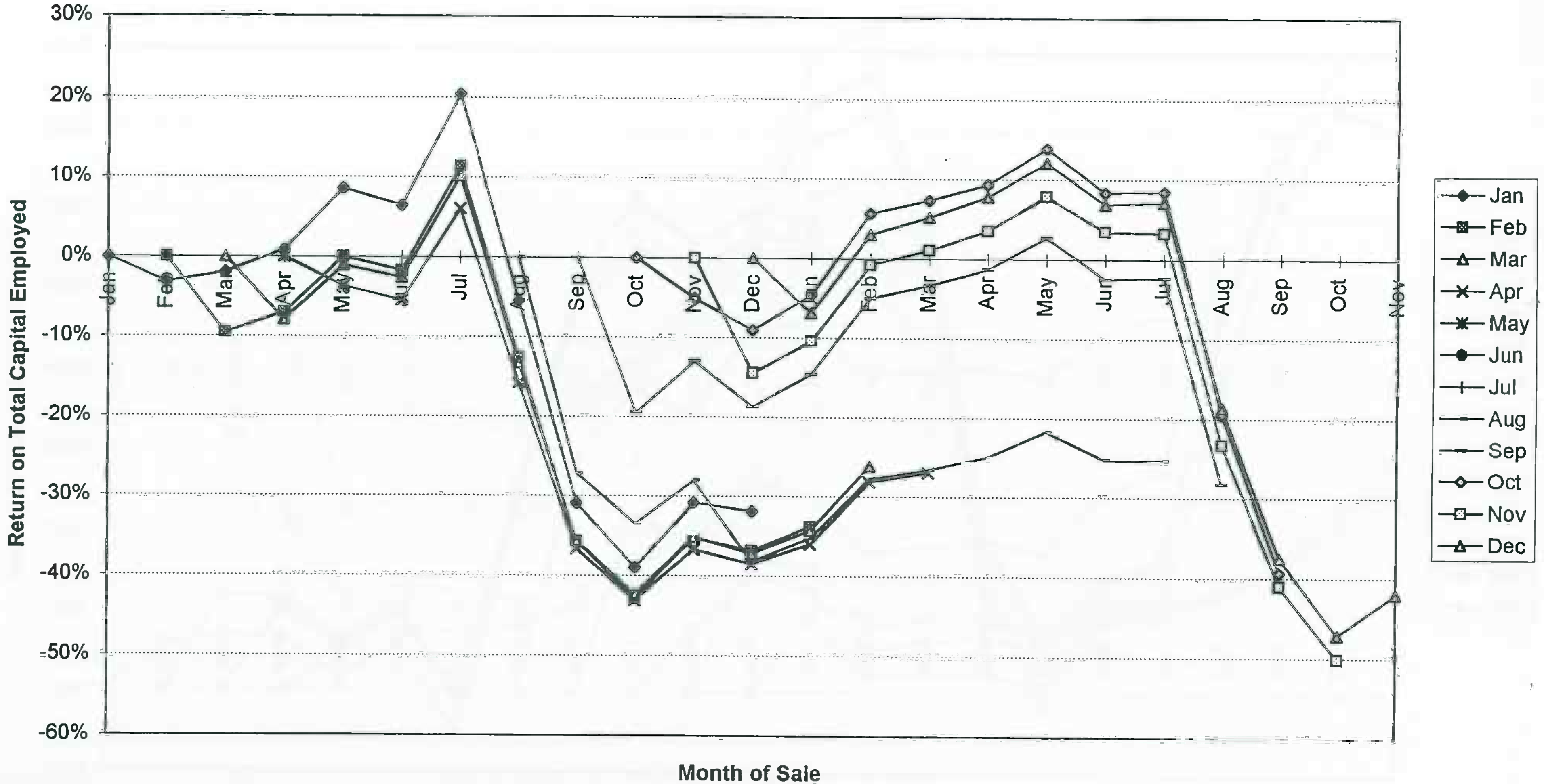
Assumptions:
Weight loss 2% - 10%
SGS Monthly Charge Rates
(C 10,000 /t/month)

Figure 8: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Tamale, Ghana (Average for the period 1990-96)



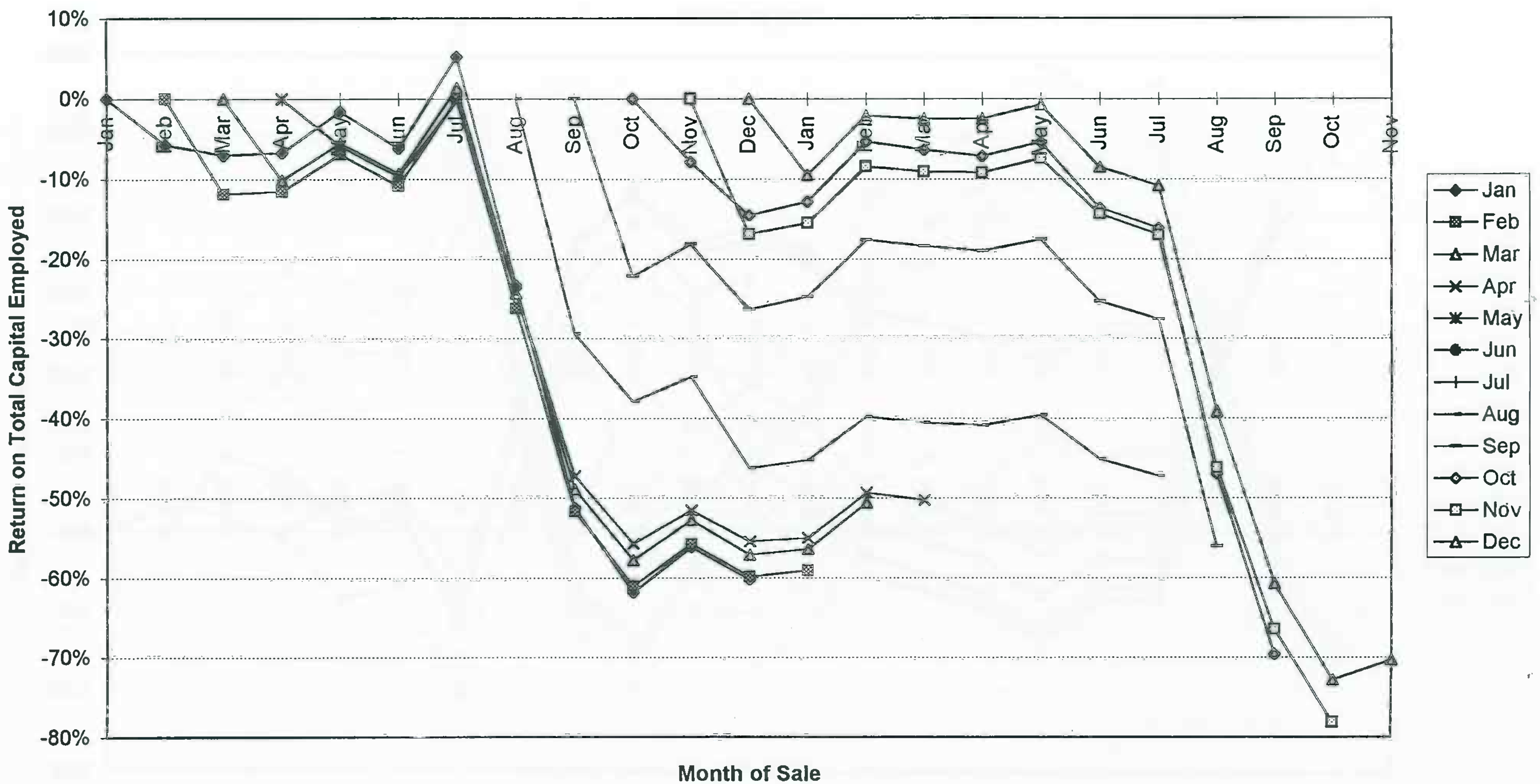
Assumptions:
Weight loss 2%
GFDC storage charges @
C 2,000 /t/month

Figure 9: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Tamale, Ghana (Average for the period 1990-96)



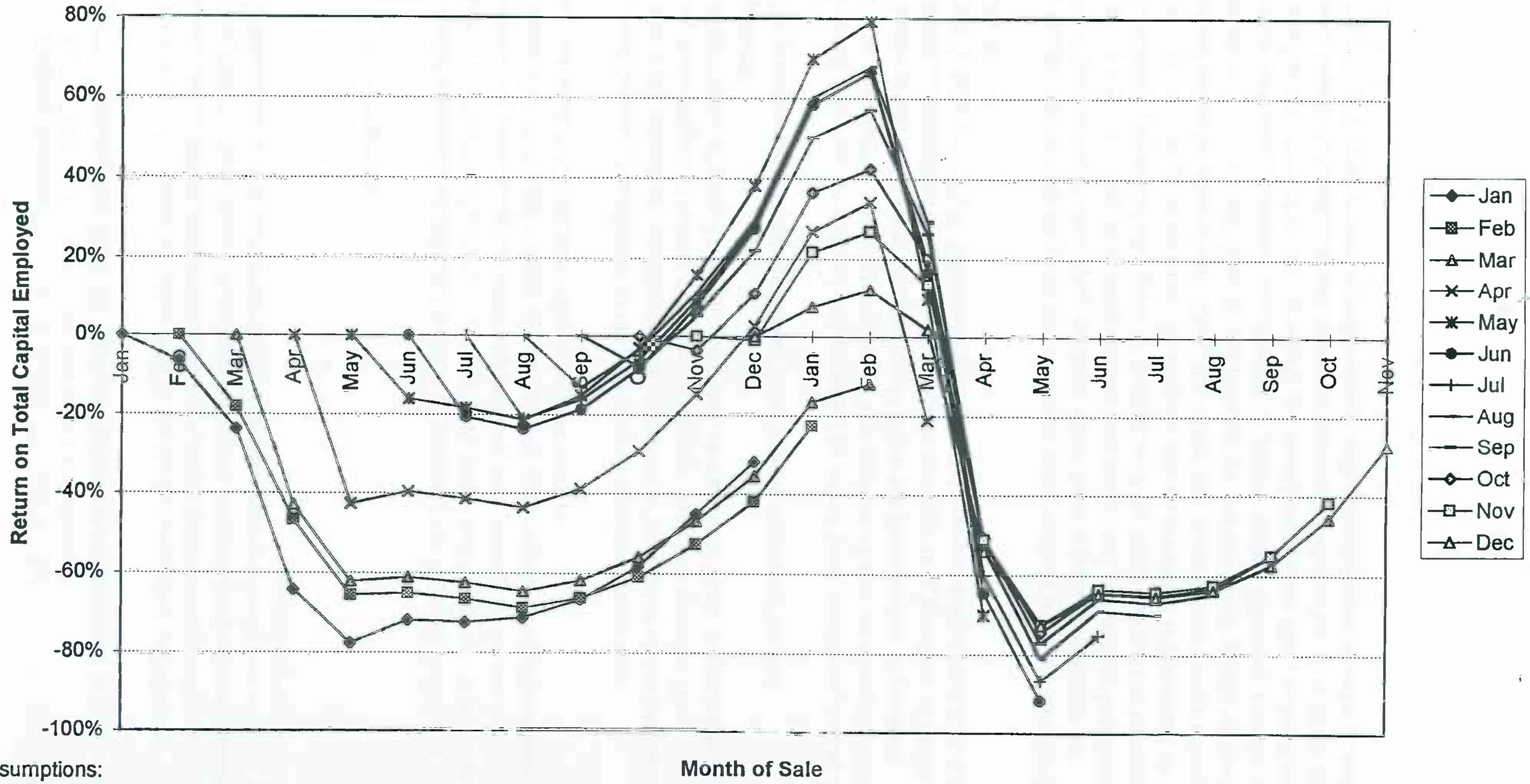
Assumptions:
Weight loss 2%
Monthly storage charges @
C 5,000 /t/month

Figure 10: Viability of Inventory Credit: Returns by Month of Purchase for Maize in Tamale, Ghana (Average for the period 1990-96)



Assumptions:
Weight loss 2%
SGS storage charges @
C 10,000 /t/month

Figure 11: Viability of Inventory Credit: the case of maize in Kabwe, Zambia (average returns for the period 1994-6)



Assumptions:
Weight loss 2%
Monthly storage costs
ZK 5200/t/months
Real interest rate 10%

5.3 Kabwe, Zambia

Results from running the model for Kabwe in Zambia are summarised in Figure 11.

- There is a marked seasonal price peak in the period December to February. This means that highly attractive returns may be earned from purchases of maize made during the low price period from May to August which are subsequently sold during the December to February price peak. Returns range up to 80%.

6. *Conclusions*

The model represents an effective method of analysing the financial viability of inventory credit, from the point of view of both lender and borrower. It provides a framework for integrating and analysing relevant data, relying on the use of historical wholesale price data, and a range of data relating to the actual costs of inventory credit. As such, it will be most effective where there is:

- a high degree of confidence in the reliability of wholesale price data
- where the influences conditioning the operation of the market under analysis have not been subject to radical change which might bring into question the effectiveness of using historical price data as a guide to likely future market price patterns
- the procurement, storage and other costs may be accurately verified.

The model may also be adapted and enhanced to reflect local conditions, and to deal with spatial as well as temporal arbitrage. The addition of data on transport costs and wholesale prices in different markets would allow the identification of potential profitable combinations of spatial and temporal arbitrage (e.g. purchase of maize in market A during month X, followed by storage and eventual sale in market B during month Y).

The model may be used to guide the actions of policy-makers or, more specifically, financial institutions in identifying markets where there is genuine potential for inventory credit lending, in guiding lending operations, and in assessing individual loan applications. The model also gives an indication of the likely riskiness of investments based on historical price patterns. Its outputs may be presented in numerical or graphical terms for ease of use. Thus, the model may make bankers more willing to undertake inventory credit lending and enhance the market-based uptake of this form of trader financing, ultimately contributing to greater market efficiency and the inter-seasonal stabilisation of prices. Similarly the model outputs are likely to be of interest to grain traders in identifying and analysing business opportunities. It is likely that the model may be further refined in collaboration with potential users in order to enhance its practical relevance.