

Investment Appraisal of an Animal Feed Plant in South Africa

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Abstract

Limpopo Province of South Africa has been successful in recent years in attracting domestic and foreign investors. One of the priority sectors favored by the provincial development strategy is agriculture, and the proposed animal feed plant is a commercial project falling under the umbrella of projects encouraged by the Provincial Government. At the same time, this project is owned and financed by a foreign investor, hence, making it eligible for the direct foreign investment (FDI) support scheme provided by the National Government.

This study completed an integrated financial, economic, stakeholder, sensitivity and risk analysis of the proposed animal feed plant in Polokwane Municipality of Limpopo Province. The plant is going to enter the existing industry where a number of domestic manufacturers already compete for the consumer. The most likely impact on the industry will be a reduction in the market share held by the existing feed producers.

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PREFACE

As part of a program to strengthen the skills in the appraisal of public sector investments in Limpopo Province, South Africa two projects that were under consideration in the Province were evaluated in detail. They are the evaluation of the Olifants-Sands Water Transfer Scheme, and appraisal of an Animal Feeds Plant in Polokwane, Limpopo Province, South Africa.

The first of these projects, the Olifants-Sands Water Transfer Scheme, is a pure public sector infrastructure project, where issues of expansion strategy, location, scale and timing of the investment were central to the financial and economic analysis.

The second project, an Animal Feeds Plant, is a commercial project, proposed by foreign investors. It has requested financial assistance from the Government of South Africa for its implementation. . It is to provide a domestic service, feed milling, and will operate largely in competition with existing domestic suppliers. At the same time most of the inputs into the feed milling and mixing process are internationally traded, as is the capital equipment used. This case is a good illustration of the perils of the public sector subsidizing private foreign investments, when the economic rational for the subsidy is not well defined.

This report has been written more as a teaching document than as a report of a feasibility study. Each step in the analysis is described in detail so that it can be used as a practical guide by analysts who are evaluating other investment projects. The report also frequently refers to the *Manual for the Appraisal of Investment Projects in South Africa* (2003), or “Manual” from nowon. This Manual contains a description of the methodology for the completion of an integrated financial, economic, stakeholder and risk assessment of potential investment projects in South Africa.

EXECUTIVE SUMMARY

Limpopo Province of South Africa has been successful over the last years in attracting domestic and foreign investors. One of the priority sectors favored by the provincial development strategy is the agriculture, and the proposed animal feed plant is a commercial project falling under the umbrella of projects encouraged by the Provincial Government. At the same time, this project is owned and financed by a foreign investor, hence, making it eligible for the direct foreign investment (FDI) support scheme provided by the National Government.

This study completed an integrated financial, economic, stakeholder, sensitivity and risk analysis of the proposed animal feed plant in Polokwane Municipality of Limpopo Province. The plant is going to enter the existing industry where a number of domestic manufacturers already compete for the consumer. The most likely impact on the industry will be a reduction in the market share held by the existing feed producers.

From the banker's perspective, the feed plant would be an acceptable project to finance under the proposed finance scheme. Debt service coverage ratios are above the 1.5 benchmark, and the bank can further reduce its risk by negotiating collateral from the project. The feed plant is an acceptable project from the banker's point of view.

For the owners of this plant, the evaluation concludes that the "break-even" milling fee is 258.8 Rand₂₀₀₂/ton, under the given investment and operating costs. If the plant actually achieves or exceeds this margin, the owners will have a profitable business, while a failure to maintain the break-even milling fee would mean a financial loss.

The economic evaluation reveals that the project will have a negative impact on the economy. The net present value of economic resource flows is -14.46 million Rand₂₀₀₂, which signifies a loss in the economic welfare. This negative economic NPV is largely fueled by negative economic externalities from the foreign exchange premium through additional usage of tradable inputs. The project is not going to pay financially for this premium, and the economic costs are borne by all the other economic agents in South Africa. The National Government should consider whether it should support such projects, which tend to benefit the foreign owners and make the South African residents to assume the economic costs.

The estimated present value of economic externalities generated by the project totals to –4.00 million Rand₂₀₀₂. The allocation of this negative externality is such that the domestic labor gains an amount of 4.65 million Rand₂₀₀₂ in externalities, and the National Government incurs a loss amounting to 9.04 million Rand₂₀₀₂.

The financial and economic model of the project is very sensitive to the following parameters: change in cost of feed ingredients, change in milling fee, economic opportunity cost of capital, foreign exchange premium, disturbance factor to real exchange rate, domestic inflation rate, tax holiday duration, accounts receivable, accounts payable, composite demand elasticity for meat, and supply elasticity of feed by other manufacturers.

The results of the risk analysis suggest that the project is likely to have even poorer financial and economic performance than in the deterministic model. The expected values of the financial and economic flows are lower than the computed net present values, and there is a 60% chance of project failure for the owner's point of view.

The National Government may reconsider its incentives policy towards foreign investment in order to make the grant rules more flexible and to create a better selection shield against projects harming the competitive domestic producers. The particular issue of whether the grant is the most appropriate form of incentive for foreign investment is very questionable. It is also doubtful that the Government's true intention is to support foreign investors in the sectors where existing domestic producers are competitive. Such a case does not justify for the direct government intervention and, instead, is likely to create an artificial distortion to the market forces. The economic will lose due to a cut back in the production by the existing domestic producers, while the foreign investor could be the one enjoying the benefits.

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LIST OF ABBREVIATIONS

ADSCR	-	Annual debt service coverage ratio
AFMA	-	Animal Feed Manufacturers Association
AR	-	Accounts receivable
AP	-	Accounts payable
CF	-	Conversion factor
CB	-	Cash balances
CRI	-	Cambridge Resources International
DSCR	-	Debt service coverage ratio
DFED	-	Department of Finance and Economic Development
DWAF	-	Department of Water Affairs and Forestry
DTI	-	Department of Trade and Industry
EOCL	-	Economic opportunity cost of labor
EOCK	-	Economic opportunity cost of capital
FDI	-	Foreign direct investment
FOREX	-	Foreign exchange
IRR	-	Internal rate of return
GIS	-	Geographic Information System
OSWTS	-	Olifants-Sand Water Transfer Scheme
PV	-	Present value
RDP	-	Reconstruction and Development Program
ROI	-	Return on investment
SMEDP	-	Small and Medium Enterprise Development Program
WACC	-	Weighted average cost of capital

1. INTRODUCTION

It has been the task of the Department of Finance and Economic Development (DFED) to identify and promote new promising projects in various sectors of the provincial economy. The animal feed production was in the scope of the Limpopo Province Economic Development Strategy.

This interest in animal feed production was amplified further by a report prepared in 2001 for a foreign firm willing to invest into this industry. The foreign firm became interested in launching a feed production plant in the Limpopo Province to serve the local market and, possibly, other regions as well as neighbor countries.

Development of the agriculture sector is one of the top priorities in the Limpopo Province Economic Development Strategy, and animal feed production falls under the range of activities, being encouraged by the Government. In addition to that, the National Government has also determined its support for fostering foreign direct investments (FDI) into the Province under its “Small and Medium Enterprise Development Program” (SMEDP). According to this policy, certain FDIs are eligible for a grant from the National Government, if the project in question is expected to contribute substantially to the economic growth of the Province.

This project is of interest as an investment appraisal case study for two reasons. First, it is a case of a foreign investment in an activity which is principally a domestically based service. Although the service might be in great demand and highly valuable, it must be kept on mind, that it is unlikely to generate substantial net foreign exchange earnings. At the same time, the economy will need to incur investment costs in foreign currency. Hence, it is a type of foreign direct investment that can not be considered to represent a net inflow of foreign investment funds into the country.

Second, this project has applied for a capital subsidy from the Government and for other local investment incentives. Hence, even if the project is highly worthwhile as a private investment, the appraisal from the Government’s point of view needs to assess if the proposed feed project actually generates sufficient economic externalities to justify the use of public sector resources to attract the foreign investment into country.

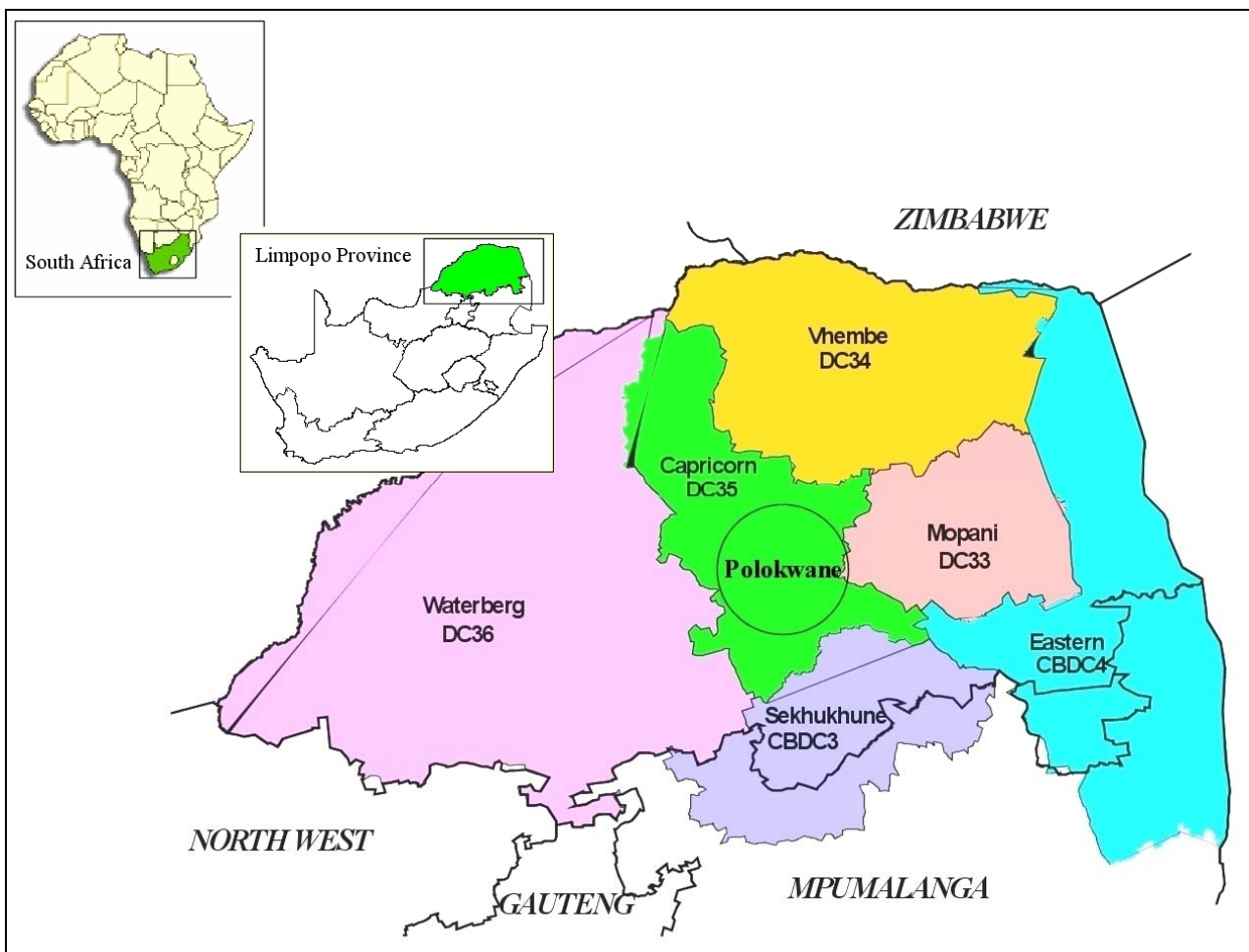
Evaluation of the animal feed project was carried out with full cooperation of the firm's representatives. Department of Finance and Economic Development facilitated the logistical support and was represented by Mr. D. M. M. Modjadji, Director of Planning and Research. Mr. Andrey Klevchuk was appointed by Cambridge Resources International to conduct the evaluation under overall supervision of Prof. Glenn P. Jenkins from CRI.

2. PROJECT DESCRIPTION

2.1 Location

The proposed animal feed project is to set up a plant in the vicinity of Pietersburg, the capital of Limpopo Province, Republic of South Africa. The foreign investor has already purchased a plot of land in Polokwane District, Limpopo Province, for the purpose of launching this business. Figure 1 pinpoints the geographical location of the proposed project.

Figure I: Locality Map of Animal Feed Plant.



2.2 Project Scope

This study carries out an integrated financial, economic, stakeholder and risk investment appraisal of the proposed animal feed plant with annual production capacity of 360,000 tons. The plant will be capable of mixing high-quality feed for cattle, pigs, broilers, egg-layers and game

animals. The inputs for animal feed include, but not limited to: maize and its by-products, corn silage, wheaten bran, molasses, sorghum, fibber, feedlime, cotton seed, sunflower oilcake, soya oilcake, fish meal, urea and possibly other ingredients.

The feed is expected to sell mostly to the local animal breeders, and probably also to other regions within South Africa. It has been stated that export of feed may be feasible to the neighboring countries if the product's price is competitive. The possibility for exporting the feed to Middle East (Saudi Arabia) was under close consideration, but this opportunity must be further explored before making any quantitative projections.

There are many feed ingredients locally available in the Limpopo Province, but some of them have to be purchased from other regions or neighboring countries. Thus, such ingredients as maze, sunflower oilcake, soya oilcake, fish meal, and urea will have to be imported into the Limpopo Province.

All the equipment and technology of feed production are to be replicated from an existing feed plant abroad, which is already operated by the foreign investor. Given the fact that the plant in Pietersburg will be an identical copy of its overseas counterpart, such a transfer of skills and experience in this industry facilitates the planning for this project.

The foreign investor has purchased the land and initiated the transfer of the equipment from the home country. The delivery of equipment and its on-site installation is expected to take 12 months or so. Thus, it is expected that the plant will start operation in the second half of 2003. It will take another 12-18 months to reach its full capacity of 360,000 tons, if market conditions allow this.

The foreign investor is planning to finance, build, operate and own the whole enterprise. Since the project qualifies for the grant under SMEPD, it will receive a cash subsidy from the Government, not exceeding Rand 3 million. This enterprise will also enjoy the other incentives available for start-up companies in Limpopo Province. The expected lifespan of the project is 10 years from the commencement of operation.

3. ANIMAL FEED MARKET

3.1 Animal Feed Production

The demand for animal feed is a derived demand arising from the demand for meat. Feed consumption is largely driven by commercial farms that typically need an additional food supplement for the intensive raising of meat animals and poultry. Production of animal feed in South Africa is an established industry. The main player has been the Animal Feed Manufacturers Association (AFMA), with the market share of about 60% of the total feed sales.

Table I represents the feed market segmentation in a typical year, 1999-2000. The South African animal feed industry in the year 1999 had an annual turnover of about 8 billion Rand generated by sales of 7.6 million tons of feed. The organized feed sector represents 4.4 million tons with a further 3.2 million tons of feed being mixed by the informal sector, including feedlots. Based on these figures, the animal feed industry is one of the largest individual organizations serving South African agriculture.

Table I. National Animal Feed Production from April 1999 to April 2000¹.

TYPE OF FEED (metric tons)	AFMA Sales (Including concentrates)	Market Share	Informal Sector	Share	TOTAL	Share by Feed
Broilers	2,133,077	97.3%	59,923	2.7%	2,193,000	28.8%
Layers	767,062	89.8%	89,938	10.5%	854,000	11.2%
Dairy	731,498	47.2%	819,695	52.8%	1,551,193	20.4%
Beef & Sheep	398,334	25.6%	1,154,666	74.4%	1,553,000	20.4%
Pigs	251,201	39.8%	380,030	60.2%	631,231	8.3%
Dogs	106,922	50.4%	105,078	49.6%	212,000	2.8%
Horses	21,179	17.5%	99,868	82.5%	121,047	1.6%
Ruminants - other	8,935	2.5%	353,857	97.5%	362,792	4.8%
Other mixtures	56,350	42.8%	75,164	57.2%	131,514	1.7%
TOTAL:	4,474,558	58.8%	3,135,219	41.2%	7,609,777	100.0%

Source: Griessel, M. (2001), Animal Feed Manufacturers Association (AFMA), Rivonia, South Africa.

The growth in the animal feed industry over the past 10 years has only been 10.7% according to Briedenhann (2001). The production and sales of animal feed tend to be concentrated in the regions where a specific meat production is dense, due to the relatively high cost of feed transportation. Even pelletized feed is bulky to transport, and consumers can easily switch from

¹ Feed concentrates were converted to balanced feeds. These figures include the production of Lesotho Farm Feed Mills and exports to neighboring countries around South Africa.

one manufacturer to another if the differential in transportation cost makes it attractive. Mostly due to this reason, only a little amount of animal feed is exported outside South Africa and where this takes place, the producer is likely to be located close to the national border. Regional sales of animal feed are quite frequent, and in the times of feed shortage customers may order feed from a producer as far as 800 kilometers away. Nevertheless, the feed market predominantly serves the domestic consumer and, hence, animal feed is classified as a “non-tradable” commodity.

3.2 Feed Ingredients

The essence of the feed production business is the mixing of various ingredients into different types of feed with specific nutrition content. Thus, the availability of raw materials is a crucial factor for the survival of a feed plant. The amount of raw materials available for local feed production depends on the crop yields and human consumption of feed ingredients. The availability of local raw materials determines the amount of imported ingredients to be imported from abroad or other regions of South Africa.

Internationally over 500 raw materials are specified by their nutritional values for possible use in animal feed, as Hasha (2002) suggests. However, the actual mix of ingredients used in the feed production will depend on the availability and price of the ingredients, season of the year, and foreign exchange rate, as well as other factors. The feed ingredients are close substitutes, their prices tend to be correlated in the movements, and the analysts agree that maize prices directly affect the prices of many other feed ingredients. In turn, the domestic maize prices in South Africa are directly determined by world prices. In years where there is a maize surplus the domestic prices will be derived from the prices of maize exports. Briedenhann (2001) points out that during years of shortages the maize price will automatically switch to import (cif) parity. In other words, the feed ingredients are largely “tradable” commodities, with their prices heavily influenced by the international factors.

3.3 Animal Feed Supply in Limpopo Province

There are two ways to obtain animal feed in Limpopo Province for a farmer. The first is the natural grazing, which is not available any time of the year, and/or production of an own-made feed mix at the farm from ingredients purchased elsewhere. The second way is to purchase a complete

formulate feed from a branded manufacturer. As a matter of fact, most of the farmers in Polokwane combine the two methods to ensure the needed nutritious content at the lowest possible cost. While the commercial feed is definitely not the cheapest solution for the farmer, it does help the farmer to save energy and time during bad grazing seasons. The problem with the natural grazing is that there is less and less land suited for intensive grazing, and it is not always available when needed.

As our investigation suggests, many farmers indeed tend to mix the feed on site, or to purchase semi-processed or raw by-products from the mills. This practice can be explained by a set of factors affecting the process of animal breeding:

- need to change the vitamin and calorie content of the feed during the different stages of animal growth;
- quality of the feed;
- freshness of the feed, which tends to deteriorate if stored for long;
- lower transportation and handling costs if the farm is self-sufficient in feed production;
- full control over the process;
- lower labor costs, since the workers, already employed at the farm, can be used to handle the mixing.

On the other hand, the feed manufacturers offer a certified quality feed mixture at any time of the year, and most of the commercial farmers increasingly use such feeds in order to ensure a stable animal mass growth. The following four are the major suppliers used by animal production units in and around Polokwane: Meadow Feeds in Randfontein and Delmas, Silgro Feeds (Genfood) in Marble Hall and Silverton, OTK Feeds in Delmas, and ALZU Feeds in Middelburg. The two much smaller local suppliers are Brenco in Louis Trichardt and Driehoek Voere at Vaalwater.

The analysts from the Department of Economic Planning and Research at the Provincial Government have already considered the animal feed production to be a potent project in the framework of the long-term provincial economic development. Annex D of “The Northern Province Industrial Development Strategy 2000” (2000) conducted a pre-feasibility study on animal feed production in the Province. One of the findings was that more than 80% of the ingredients used in the production of animal feed are imported into the Province. The province is currently not a major producer of maize, and research needs to be made to determine whether

maize can be grown commercially in the Province or if suitable substitutes are available to use instead of maize for animal feed. Studies that have recently been conducted suggest that sorghum could be an effective replacement for maize as the energy component in a feed formulation. Comparisons between the nutrient value of sorghum and maize show that the feeding value of sorghum is 85 to 97% of the equivalent value of maize.²

3.3.1 Provincial Feed Industry

It is quite cumbersome for a farmer to do own mixing of the feed, because the farmer will have to procure a constant supply of ingredients at an affordable price level. The feed manufacturers make life somewhat easier for the farmers by offering the ready made feed locally and there is no need for the farmer to deal with the purchase, storage and processing of feed inputs. The organizational structure of the feed market in Polokwane is a web of independent feed manufacturers, each of them caring mostly to local consumers. The high transportation costs enforce the consumers to compare the prices of the different manufacturers by including the associated transportation and time costs.

In other words, an individual farmer faces a situation where he is free to choose between the local and remote manufacturer, and the choice will depend on the two feed different prices as well as time and transportation costs. When the total costs are equal, the farmer will be indifferent between the two manufacturers but if one of them is lower, his preference will be definitely given to the cheaper product, assuming that the feed quality and all other factors are identical:

$$\text{Price}_{\text{Feed}}^{\text{Local}} + \text{Cost}_{\text{Time}}^{\text{Local}} + \text{Cost}_{\text{Transport}}^{\text{Local}} = \text{Price}_{\text{Feed}}^{\text{Remote}} + \text{Cost}_{\text{Time}}^{\text{Remote}} + \text{Cost}_{\text{Transport}}^{\text{Remote}}$$

What is typical to observe is that the farmer is more likely to prefer the local manufacturer, because the other feed producer faces the same input costs and any feed price differential is typically absorbed by the higher transport costs. However, emergencies at the farm and feed

² A wide range of other products that are suitable for inclusion in animal feed is available in the Northern Province. These products currently have very little commercial value and require specific research into the nutrition implications and the economics of their inclusion in animal feed formulations. A list of these products is provided: citrus and other suitable fruit peels, cotton seed, spent grain (hops and sorghum), spent grain from mills, cassava starch, lucerne and roughage (production to be encouraged), under grade potatoes and potato peels, chicken manure, sickel bush, feather meal, fryer oil. Feather meal is a particularly interesting case in the sense that it is a valuable protein source and protein is the most expensive ingredient in any feed formula. There are large broiler and egg production facilities in Northern Province, but poultry feathers are being discarded.

shortage at the local producer do from time to time force the consumer to order feed from remote manufacturers.

In other words, the market structure of the feed industry in Limpopo Province resembles a monopolistic competition, where the nearest feed producer behaves as a local monopoly as long as its feed price is competitive with the others' price plus the time and transport costs. An important implication of this market structure is that if a manufacturer is able to provide the feed at a lower cost, the consumers will easily switch from the other brands to this manufacturer. Any new big producer will definitely impact on the market share of the existing manufacturers.

3.4 Animal Feed Demand in Limpopo Province

The conclusion of "The Northern Province Industrial Development Strategy 2000" (2002) said that there is a potential for the expansion of the animal feed production in the Province. There are well-established cattle, pig and chicken commercial farms in the Province, as well as there are an increasing number of smaller scale producers. The study conservatively estimated that the provincial feed requirements in 2000 were approximately 230,000 tons, which included the major beef feedlots, broiler and pork production, and egg layers. This figure did not include the numerous small and farmers and game feed requirements.

3.4.1 Game Farming

What is special to Limpopo Province, compared to other regions of South Africa, is that it has many game farms and their number is growing year by year as farmers find it more profitable to care for the game animals. Eloff (2001) estimated that among the other provinces of South Africa, Limpopo Province had the highest number of game units sold (6,377 units) and the biggest market share (31.5%) in the industry in 2001. Unfortunately, there is no reliable statistics on the quantity of feed consumed at game farms in Limpopo Province, but it is expected to be a substantial portion of the total feed consumption.

Preliminary market research conducted by interviewing game farms indicated that they can be a potentially lucrative segment of the feed market in Limpopo Province. Several factors contribute to this. The lack of natural grazing for game animals comes about due to decreasing the territory of areas suitable for grazing and due to decreasing availability of natural water. At the same time, the number of game farms and variety of species bred there has been steadily increasing over the last

years, and this trend is expected to continue. This can be explained by the increasing tourism demand for the sites situated in the province. Despite the promising expectations about demand for game feed, there are no reliable estimates of the total amount of game feed demanded.

3.4.2 *Project's Demand*

At present, there are no reliable estimates in regard to the total provincial animal feed requirement. Using the results of the 2000 study as the basis, the feed total requirement, inclusive of the game farms, can be conservatively assumed at 400,000 metric tons a year. An annual growth rate of 3.0% allows to extrapolate this figure to year 2002 with a tentative estimate of 424,360 tons/year. This figure is likely to underestimate the real consumption of the animal feed.

Given the estimated size of the market, a feed production plant with a capacity of 360,000 tons per annum will be a very big facility for Limpopo Province. Obviously, this feed plant will divert some of the consumers from the existing producers and will force the less efficient manufacturers either to quit the industry or to penetrate further to other regions.

In this situation, the new producer has to be flexible enough to offer the required variety of the rations, as well as to be fast enough to deliver the product fresh to the farmers. There is a growing concern about the safety of animal feed and as Speedy (2002) underlines that the feed industry must ensure a safe and healthy diet for the meat animals. It is also important that the pricing of commercially prepared feed be very competitive with the prices of the other manufacturers and cost of doing the mix on-site. Of course, there must be a price difference to induce farmer to switch from other producers or his own on-site mixing facility to purchase the feed from the new proposed plant.

There is no guarantee that the project will be able to market all of the feed it can technically produce because the provincial market is already supplied by other manufacturers. The management can take an aggressive approach by artificially lowering the prices and by marketing the products to other regions. However, the price reductions only can be a temporary measure to fight for the market share, and the average break-even price must prevail in the long-run in order to stay in the business.

4. METHODOLOGY

4.1 Objectives of Financial Analysis

Any project can be examined from several points of view, or “perspectives”, as Chapter 2 of the *Manual (2003)* suggests. The project owner and operator are likely to be more interested in the financial strength of the enterprise, and its ability to generate a sufficient return on investment. The bank(s), who finance the project, wish to ensure a secure repayment of the funds loaned to the project, and they look for the project’s ability to generate enough cash to meet the debt payments over years. In respect to the financial analysis, this animal feed plant is a typical commercial project, which can be evaluated upon from the “banker’s point of view” (does not include loan financing and loan repayment), and from “owner’s point of view” (including loan financing and its repayment). Section 5 is devoted to the financial analysis of the proposed feed plant. Section 5.14 examines the project from the banker’s point of view, and the discussion of Section 5.15 reflects the owner’s point of view.

The main questions on the agenda of financial analysis is to assess the financial viability of the project with the given prices of raw materials and feed for both owner’s and banker’s points of view. Another way to look at the financial performance of the project is to find the break-even fee between the cost of raw materials and price of feed per ton, so that the net present value of the project is equal to zero, since the National Government is involved in partially financing the enterprise through an investment grant.

The Government should see whether the project is financially viable on its own, without the Government’s support. If the proposed project is financially sound, then the question is whether the National Government should give the investor any further incentives, which can be a harmful disruption of the existing market mechanism. Also, the form of investment incentives is also questionable, especially the cash grants to new foreign investment projects, which should be really financially and economically justified. The Government must evaluate the project’s financial impact on its revenues collections to see if the project’s net impact overweighs the grant by higher amount of tax collections.

4.2 Objectives of Economic and Distributive Analysis

The economic appraisal looks at the economic impact created by the project and Section 6 contains the economic analysis of the proposed feed plant. The economic analysis poses a challenge for the evaluation of the project because many economic values are not observed in the market place and, hence, adjustments need to be made to the financial values in order to arrive at the economic values for the inputs and outputs of the project. Sections 6.2–6.4 deal with the estimation of the economic conversion factors for the construction inputs and the economic value of animal feed. The main objective of the economic analysis is to see if it is justified to provide a grant for this type of business, and whether the grant is the most appropriate instrument to stimulate growth in the sector.

The net present value of the economic benefits less economic costs, will indicate whether the net economic benefits, measured in terms of year 2002, are greater than zero and project is a net contribution to the country's welfare. The flows of real economic resources associated with this project must economically justify their employment at this project, since there are other sectors where the resources can be successfully used. The modeling of economic resource flows and calculation of the economic NPV are discussed in Section 6.5.

Creation of the economic externalities is an inevitable consequence of any project, and their estimation is an important component of the project evaluation. Section 7 is devoted to the estimation of externalities and distributive analysis. The economic externalities are the difference between the financial and economic values, which can be either negative or positive. Section 7.1 discusses the modeling of the externalities flows and computation of the present value of total externalities. The reconciliation between the financial and economic analysis is done in Section 7.2.

The next logical step after economic analysis is the stakeholder impact assessment, which actually looks at the distribution of the externalities amongst the different parties affected by the project. The main question is who stands to win or lose from the introduction of this project and by how much. The government may want to interfere and change the design of the project or the pricing structure in order to obtain a more attractive set of the distributional impacts from the project. Since the feed project is owned by a foreign company, the stakeholder analysis is essential to distinguish between the benefits and costs incurred by the foreign owner and these accruing to

participants in the domestic economy. Section 7.3 looks after the task of allocation of the economic externalities generated by the project.

The government needs to assess the economic impact of the project. It should evaluate the direction and magnitude of the economic benefits and costs created by the project that may not fully be reflected in the financial analysis. Section 7.4 examines these issues.

4.3 Objectives of Sensitivity and Risk Analysis

Sensitivity tests are performed on the financial, economic and distributive analysis results in order to assess the degree of vulnerability of the project to various exogenous variables. Sensitivity analysis is a convenient way to understand how to re-configure the structure of the project so that it becomes less vulnerable to possible hazards. Sensitivity tests have been used throughout the financial and economic analysis in order to detect the crucial project's variables. Once such parameters are located, the project's owners and government may re-design the project to improve its performance, if needed. There are two sections with sensitivity tests: Section 5.16 contains the financial sensitivity tests and Section 7.5 has the economic and stakeholder impact sensitivity tests.

The risk analysis is carried out in Section 8, after identifying the risky and uncertain variables of the project. The main objective is to test the behavior of the project under the most "realistic" circumstances, generated under the risk simulation. A comparison between the "static" project indicators and resulting risk "expected values" of these indicators reveals the likelihood of the project to achieve the performance targets.

4.4 The Method and Tools

The methodological framework of this study follows the state-of-art investment appraisal methodology developed by Jenkins and Harberger over the past 30 years and well-described in the *Manual* (2003). The present study is an illustrative application of the methodology laid out in the *Manual*.

The strong analytical framework is embedded into a computer-based mathematical model constructed in the Microsoft Excel[®] spreadsheet processor. The actual modeling procedures and formulas for project appraisal have been developed by Cambridge Resources International. The

risk simulation is modeled with the help of risk analysis software Crystal Ball[®], developed by Decisioneering Inc. The integrated financial, economic, distributive, sensitivity and risk analysis is modeled into a single spreadsheet, and tabulated results are available in Annex A.

4.5 Model Overview

The analysis of the feed project is based on a mathematical model of the given and estimated technical, financial and economic parameters. This analysis is done by using the Microsoft Excel spreadsheet processor. All the relationships among the parameters are expressed in formulas, which are constructed in such a way that any change in the basic parameters is automatically reflected in all the consequent formulas, and final results are also adjusted. The model of the project is built in steps, where “tables” are a set of links and relationships among variables, serving a specific function in the model. Figure II outlines the steps in the feed project, and shows the tables used in the model. A detailed description of each table will allow the analyst to replicate the model.

Figure II: Overview of Integrated Financial, Economic, Distributive and Risk Analysis of Animal Feed Project.

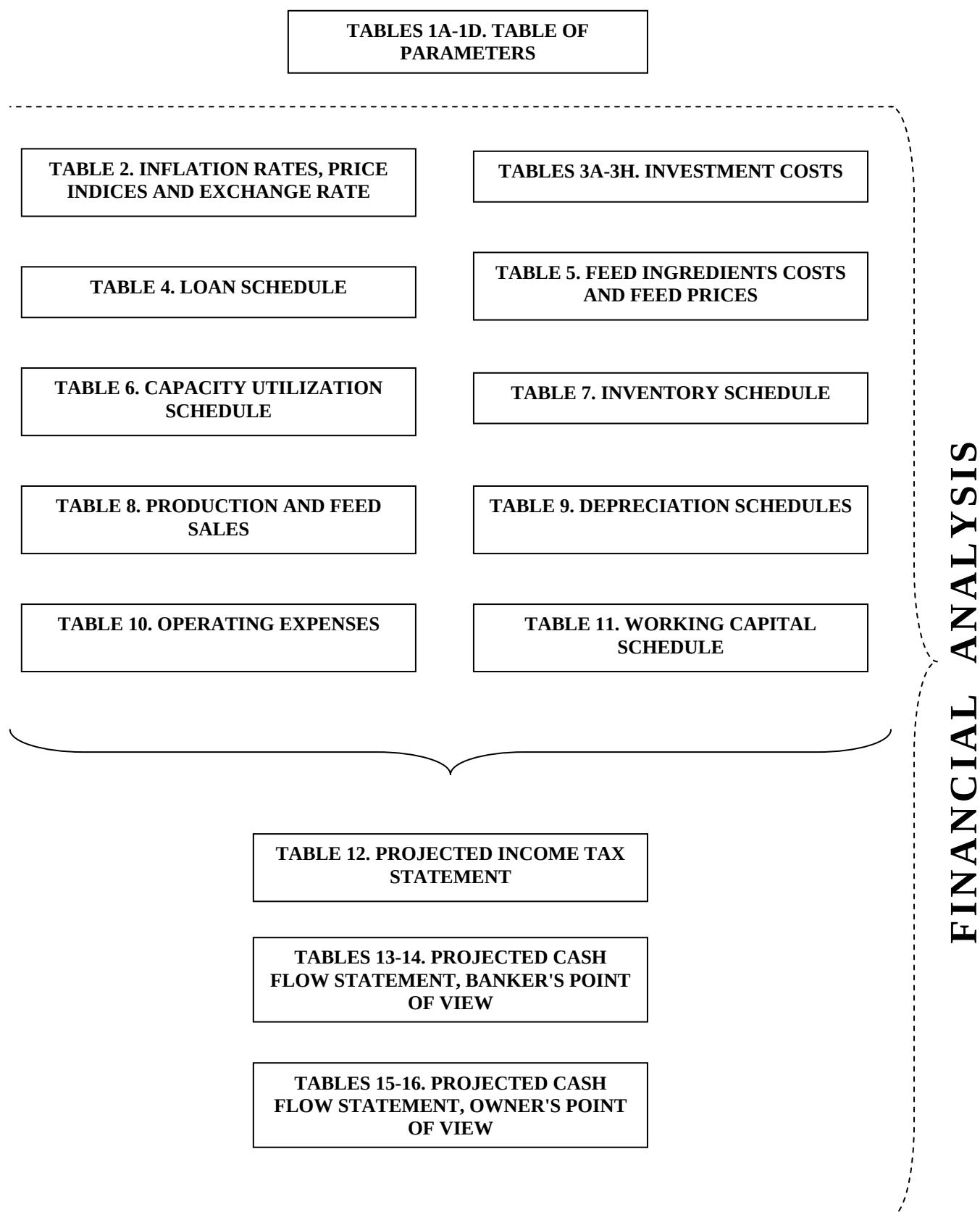
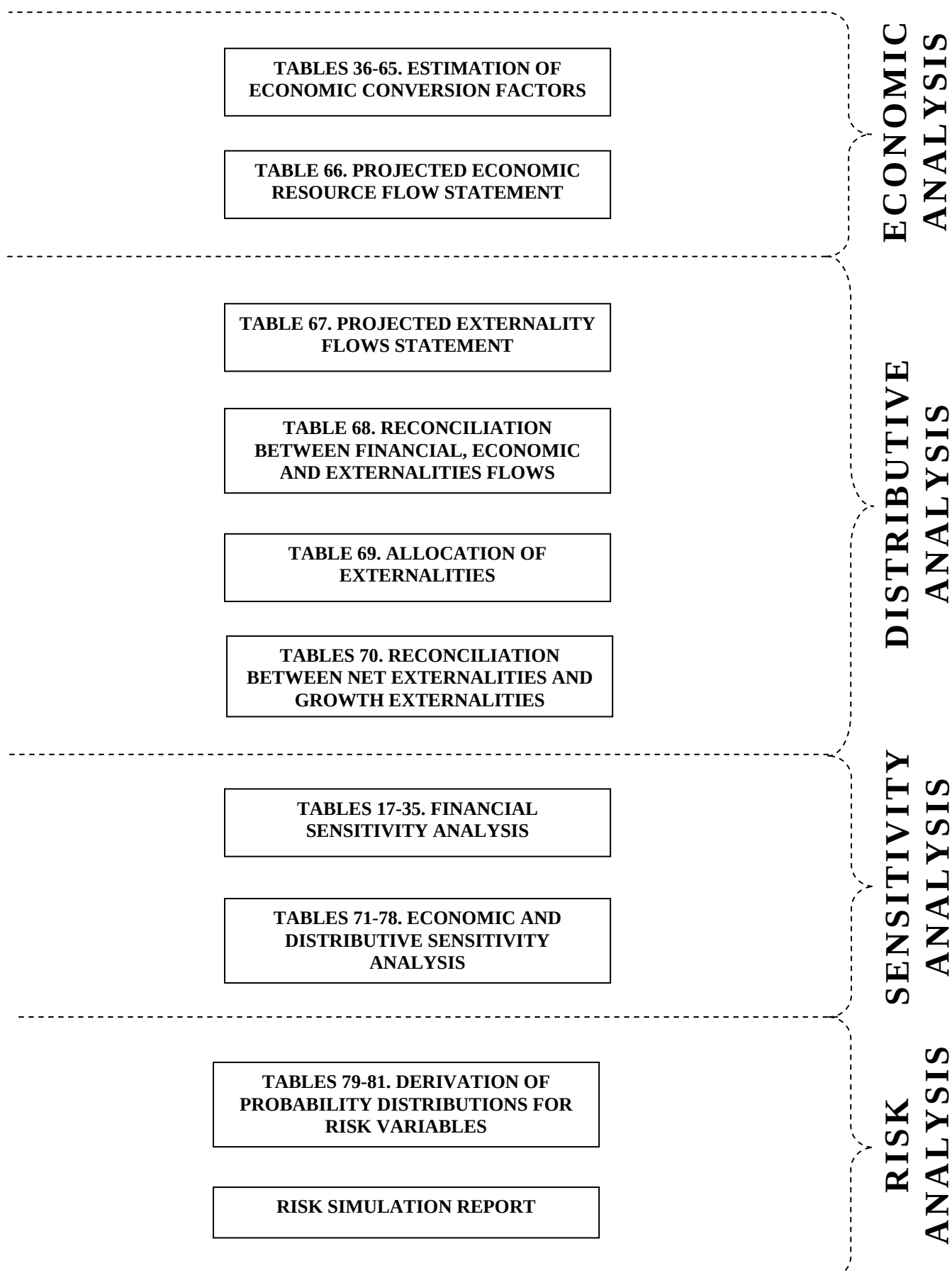


Figure 2. Overview of Integrated Financial, Economic, Distributive and Risk Analysis of Animal Feed Project. [Continued]



5. FINANCIAL ANALYSIS

5.1 Scope of Financial Analysis

Several objectives are pursued in the financial analysis of the animal feed production in Limpopo Province. The central issue is the viability of commercial feed production under the existing market conditions and the technology of the proposed plant. This financial analysis of the proposed feed project is carried out from two alternative evaluation perspectives: “banker’s (or total investment) point of view” and “owner’s point of view”. The main question here is to determine if the proposed plant is a feasible investment. If not – then what are the factors, which gravely affect the projected financial performance of the project.

The “banker’s point of view” evaluates the project without including any loan items into the cashflows, in order to determine the overall financial potential of the project. Any grants and subsidies which are not originating from the bank are included into the cashflow. If the project seems to be performing well on its own then the project might be eligible for a loan. Annual debt service coverage ratios (ADSCR) and debt service coverage ratios (DSCR) are calculated for various financial schemes using the proposed plant configuration and prices of raw materials and output. The analysis helps to determine if the amount of borrowed funds are likely to be repaid in full with the given financial structure of the project. Section 5.14 contains the results of the financial assessment from “banker’s point of view.”

The “owner’s point of view” is the second step of the analysis, and is simply the evaluation of the proposed project as it is perceived by the project owner. Looking at the feed plant from this perspective, the cashflows will include all grants/subsidies, as well as the cashflow items related to external finance, i.e. loan funds and their repayment. The relevant measure of performance is the net present value (NPV) of the cashflows, which signifies the overall financial performance of the investment over years. The internal rate of return (IRR) criteria is also calculated, but it does not play a role as a decision tool. Section 5.15 examines the proposed feed project from this evaluation perspective.

In order to look at the project from different evaluation perspectives, a financial model should be completed. Sections 5.2–5.12 are devoted to the discussion of the modeling procedures of such a financial model. Section 5.13 prepares an income tax statement for the enterprise.

5.2 Model's Assumptions: Table of Parameters

Construction of the Table of Parameters is the starting point of the modeling process. It is really a set of fields in the spreadsheet, where all known parameters of the project are recorded. All consequent formulas are built through links to the Table of Parameters and, therefore, it is important to place all variables into this table, instead of scattering them in various locations in the spreadsheet. Having all data in one place makes further references quick and ready. The Table of Parameters is shown in Tables 1A–1D in Annex A.

It is useful to divide the available information about the project into logical sections, such as timing, technical data, financing, taxation, economic parameters and etc. The parameters are usually taken from preceding technical studies, or from experts, from the professional literature, from market observations, or are assumed.

If an assumption is made, the analyst should make a reasonable estimate of the assumed variable, and give an explanation why a certain value is chosen. Very often some data either are not available or are costly to obtain, but a reasonable assumption is acceptable for the purpose of conducting the analysis. A careful selection of the value for such cases is needed, because project may be highly dependent on the variable in question. If it appears that the performance of the project is indeed vitally linked with an assumed variable, then further sensitivity tests must be performed to assess the impact of a change in the assumed variable on the project's outcomes.

5.2.1 *Timing*

The timing section of the Table of Parameters contains the information about the start and duration of the project. Thus, the operational life of the feed plant is taken as 10 operational years, which is usually a sufficient period for a commercial project to pay back the initial costs and compensate the owner(s). The starting point of the project, so-called "Year 0" concept, is year 2002 in which the physical construction of the plant takes place. Although that the construction time is, at least, 12 months, the plant owner believes that the operation can be launched somewhere at the end of year 2003. Therefore, year 2003 is the first operational year of the project, while the last operational year is 2012.

After operating for 10 years, the plant is assumed to shut down and be “liquidated” in year 2013. In fact, the owner may like to continue the enterprise, but for the purpose of the analysis it is assumed that all assets are liquidated for their “residual” value. Another way to look at it is to think that the enterprise is sold as on-going concern and the owner gets paid for the remaining value of the assets. Year 2013 is treated as a period in which the business is being liquidated and financial accounts are settled among the feed plant and its suppliers and customers. No operational activities take place in year 2013. A 45-hour working week is taken as the average labor work load at the plant.

5.2.2 Capacity

The capacity section contains the technical data of the plant and management plans about running it over time. The design capacity of the plant is 360,000 tons/year. Input/output conversion ratio describes the proportion of raw feed ingredients (inputs) needed to manufacture 1 unit of animal feed (output), which means that, on the average, it requires 1.1 metric ton of feed ingredients in order to manufacture 1 metric ton of feed. This ratio accounts for technical losses and shrinkage of the raw ingredients during the manufacturing process. Raw material requirements of 396,000 tons/year are calculated as a product of plant capacity and the input/output conversion ratio.

The planned capacity utilization factor is the “planned” production schedule for the plant. However, actual production may be different from the “planned” path due to a number of reasons, for instance, due to demand changes or/and changes in the cost of feed ingredients. Further analysis will deal with such events, and meanwhile the “planned” utilization of the plant capacity is 50% in year 2003, 70% in year 2004, 90% in 2005 and onwards, and 0% in year 2013.

5.2.3 Financing

This section contains parameters of the project financing, such as method of finance for investment costs and terms of external finance. The investor has expressed its intention to finance all the costs of equipment and its freight from equity funds of the company. According to the company representative, the local costs will be financed by a combination of equity and a Rand loan from a South African bank. The maximum amount of such a loan is about 50% of the local costs.

Real vs. Nominal Interest Rate: For a project of this nature and size, a commercial Rand loan can be drawn from one of South African banks. The underlying real interest rate for such kind of commercial loan can be assumed 8.50%, which transforms into a nominal interest rate of 15.01% in year 2003. As Chapter 4 of *Manual (2003)* suggests that the relationship between the real and nominal interest rates and the expected rate of inflation can be expressed through formula:

$$i = r + R + (1 + r + R) * gP^e$$

Where, nominal interest rate is represented by (i), real interest rate by (r), country risk premium by (R), and inflation rate by (gPe). Since the loan is drawn from a local bank, the country risk (R) is set to zero, and with the expected inflation rate of 6.0% in year 2003, and with real interest rate (r) of 8.50%, the resulting nominal interest rate is 15.01%.

Loan Terms: A likely, but not necessarily, set of conditions for such a loan would be a grace period of 2 years from the start of the project, a repayment period of 5 years with equal nominal annual installments. The actual nominal rate will be adjusted for the impact of the expected inflation rate(s). Thus, the repayment of the loan will begin in year 2004 and the last repayment will be made in year 2008. By definition, the ending balance of loan financing should be zero at the end of year 2008.

5.2.4 Foreign Exchange Premium

A few economic parameters are used in the model. They are taken from other studies, for instance, the foreign exchange premium on the traded goods is taken as 5.50% and on non-traded goods as 2.0%, following Chapter 9 of *Manual (2003)*.

In fact, there are more parameters for the economic analysis, but most of them are used only once and tend to be too lengthy to be included into the Table of Parameters. For example, the estimation of economic conversion factors requires a detailed break-down of cost shares for each of the many commodities. Instead of placing these values in the Table of Parameters, they appear directly in the conversion factor tables, marked as “assumed” values.

5.2.5 Discount Rates

There are two discount rates used in the analysis: financial and economic. The financial discount rate is the minimum rate justifying the use of private capital in this project. The required return on investment rate can be used as the minimum acceptable financial discount rate. In other words, the owner of funds will be willing to participate in a project only if the minimum return on investment is assured at 10.0% in real terms. Adjusting to nominal rate, inclusive of inflation, give us a nominal discount rate of 16.6%. This calculation follows the formula similar to the relationship between real and nominal interest rates, and it can be expressed as:

$$D^N = dr + (1 + dr) * gP^e$$

Where, the nominal discount rate is represented by (D^N), real discount rate by (dr), and expected inflation rate by (gP^e). With the expected inflation rate of 6.0% in year 2003 and with real discount rate (dr) of 10.0%, the resulting nominal discount rate is 16.6%. Both nominal and real rate of return on investment may be used in financial analysis, representing the opportunity cost of capital to the owners of the project. By definition, the net present value obtained by the discounting the nominal net cash flow by the nominal discount rate must be identical to the net present value obtained by discounting the real net cash flow by the real discount rate.

For the economic analysis, a different measure of cost of capital is needed, because this feed plant is one among many alternative projects, where capital resources can be productively employed. The relevant discount rate for economic analysis is the economic opportunity cost of capital (EOCK) for South Africa. As reported in Chapter 8 of the *Manual (2003)*, it has been estimated that the real EOCK for South Africa is 11.0%. This figure is used in the economic analysis as the discount rate for the stream of benefits and costs during the project's lifespan.

5.2.6 Inflation and Exchange Rates

One of the core concepts of the financial modeling is tied up with the differentiation between the “nominal” and “real” prices. “Nominal” prices are easily observed on the marketplace while the underlying “real” prices are not. The difference between the two is the accounting for inflation over time through change of the nominal prices are the real price level gross of the cumulative effect of inflation, while real prices are net-of-inflation. This section of Tables of Parameters contains information about expected inflation rate(s). Since there are two currencies involved into

this project, inflation rates have to be projected for both the US-dollar as well as for the South African Rand. The US-dollar funds are used for purchasing the equipment and for freight and transportation expenses while all other expenses are paid out in South African Rand.

Inflation Rates: The price quotations for the imported equipment date back to year 2000, and that is why the inflation rates for years 2000 and 2001 are stated. The equipment prices of year 2000 have to be adjusted by the annual inflation rates, so that they reflect the present value of equipment as of year 2002. Domestic average annual inflation rates adopted here are 6.0% for year 2000, 12.0% for year 2001, 9.0% is the expected average rate for year 2002, and 6.0% is the expected average inflation rate for years 2003 and onwards. For the US dollar, the following rates were taken as 5.0% for year 2000, 3.0% for year 2001, and 2.5% is the expected average inflation rate for years 2002 and onwards. The assumption of constant inflation rates over 10 years of plant operation will be relaxed later in risk analysis, and sensitivity tests will be done to assess the impact of changes in the assumed inflation rates on the project performance.

Exchange Rate: The average exchange rates used in analysis prior to year 2002, are 7.57 Rand/US for year 2000, and 11.00 Rand/US for year 2001. Starting the year 2002, the expected exchange rate will be modeled according to the relative inflation path of Rand and US dollar. An additional disturbance term will be also included to represent all other factors influencing yearly movements of the nominal exchange rate. It is also assumed that the underlying real exchange rate between Rand and US dollar will remain constant over years.

One parameter artificially introduced into the model is the disturbance to the real exchange rate, which is set to zero in the base case of the financial analysis to support the assumption of the constant real exchange parity between the Rand and US dollar. However, the sensitivity and risk analysis will use this parameter to simulate changes to the real exchange rate in order to test the model's responsiveness to this variable.

5.2.7 Taxation

Any project is subject to a few, if not many, taxes. It is convenient to place all tax related parameters into one section. The general value added tax (VAT) rate in South Africa is currently at 14.0%, but feed ingredients and animal feeds are exempted from VAT, being a part of basic agricultural produce. The corporate income tax rate is 30% on the income after depreciation and interest expenses. A part of incentive package for start-up businesses, the tax code grants a 4-year

period of tax holidays, exempting any profits of the enterprise from the corporate tax liability. After that, a full corporate income tax rate is applied on any profits. The rate of personal income tax is currently 25%, and the amount of gross salary above the minimum wage is taxed at this rate.

5.2.8 Working Capital

Working capital section contains the expected average amount of accounts receivable (AR), accounts payable (AP), and cash balances held (CB). Accounts receivable represents an average annual delay in cash payments, or uncollected accounts arising from sales of the animal feed to customers. It is often confused with the accounting concept of “accrual” record keeping, under which income is reported as of the date of a sale regardless of whether the sale was paid for either in cash or put on customer’s account. Opposite to this, in a cashflow analysis the sales receipts are treated on an actual cash basis, and if any credit sale takes place, its proceeds are recorded in the AR instead of being a part of actual cash sales. It is helpful to remember that any increase in AR implies a reduction in actual cash inflows, relative to the total sales. Therefore, this positive “change in AR” is actually deducted from the total sales to arrive at the amount of cash sales.

From interviews with the management of the firm, they plan to operate the business on cash basis in order to prevent bad debts from customers, but it is unlikely that they will be able to maintain such a strict policy. Under this policy, it is more reasonable to assume that the average period payment from customers would be 14 days a year, or $2/52$ weeks, or 3.85% of feed sales.

Accounts payable are treated in a similar fashion, since they are thought to represent the delay in cash payments to the suppliers of the plant. It is assumed that the average delay in account settlement would be 7 days a year, or $1/52$ weeks, or 1.92% of total operating costs. It is beneficial for the project operator to delay actual cash payment to the suppliers; as he has the flexibility of using that cash during the period of payment delay.

Cash balances held is a cash fund, kept on hand facilitate making the necessary payments. It has been assumed here that the average amount of cash balance held is 2% of the direct operating costs.

5.2.9 Labor

Labor is a distinctive input of any project. Typically, labor parameters describe the number and kind of employees, their wage rates, fringe benefits, insurance and social security payments, expected real wage growth rates, etc. A few parameters will be also needed for the economic analysis during the estimation of the economic conversion factors for the different labor types employed by the project.

Unskilled Labor

The feed plant will need 12 full-time unskilled workers in year 2003, then 16 in 2004, and 20 people will be employed from year 2005 to 2012. No personnel will be needed in year 2013. The gross monthly wage rate, inclusive of fringe benefits such as transportation, meals, and bonuses is set at 2,100 Rand, and it is expected that this rate will grow, in real terms, by 0.5% per annum.

The people employed at the plant will come from other sectors, and given the labor market situation in Polokwane, it is reasonable to assume that the two main sources of unskilled labor will be the informal farming sector and quasi-voluntary unemployed. The average wage in the informal sector (Wo) is taken as 651 Rand/month, and it is assumed the feed project will attract 10% of its unskilled workers from the informal farming sector. The remaining 90% of the unskilled employees will leave their quasi-voluntary unemployment, which earns the average income of 1,266 Rand/month. The stated parameters are enough to estimate the supply wage of unskilled labor, which is the average wage rate of the informal sector and of and quasi-voluntary unemployed, according to the Chapter 10 of the *Manual (2003)*. The computed supply wage for unskilled labor is 959 Rand/month.

There is no personal income tax on the income of unskilled labor because their salary is just at the level of the official minimum wage of 1,266 Rand/month. But there are contributions, actually paid by the employer, which accrue to the government-regulated agencies. Under the current law, the social insurance contribution is set at 12.52% of the wage rate, from which 5.0% is thought to be paid by the employee, but in reality it is paid by the firm. The compulsory contribution to the workmen's compensation fund is set at 2.55%, while the skills development fund requires an additional payment of 1.5%, and the unemployment benefit fund takes another 2.0%. All the contributions add up to 18.57% of the wage rate, which is a substantial amount and should not be neglected.

Besides the contributions, a productivity bonus is usually paid to the worker at the end of the year, and its monthly equivalent amounts to 65 Rand/month. Thus, the financial cost of unskilled employee (gross wage) becomes 1,566 Rand/month, which is computed as the minimum wage of 1,266 Rand/month plus the productivity bonus of 65 Rand/month and plus the 18.57% in contributions. All these parameters will be later used for the estimation of the economic cost of unskilled labor in Section 6.3.1.

Skilled/Semi-Skilled Labor

Skilled personnel, such as technicians, will be employed on a permanent basis and the plant will need 4 qualified employees starting from year 2003 till 2012. No skilled personnel are expected to be employed in year 2013. The real wage rate to be paid by this project is set at 14,500 Rand per month, and it is expected to rise by 0.5% annually. These figures will be used for the modeling project's labor expenses on the skilled and semi-skilled labor.

A few parameters about the labor market are needed for estimation of the economic cost of the skilled and semi-skilled labor. The prevailing market wage is taken as 12,830 Rand/month, which converts to an annual salary of 153,960 Rand/year. It is assumed that the share of personnel attracted from other sectors is 90%, and the remaining 10% are attracted from outside of the unemployed pool. The annual income tax and site tax amount to 35,409 and 8,720 Rand/year respectively, making the total amount of taxes equal to 44,129 Rand/year. A typical package of fringe benefits for skilled and semi-skilled employees is estimated as 17.07% of the annual wage.

Local and Foreign Management

The tasks of supervision and administration of the plant operations fall on the shoulders of the management. The analyst should differentiate between the local and foreign management because each has its own opportunity cost and there are different income tax implications. There is a substantial share of labor costs in the construction, and this is where the local management will be used.

But the management of the plant must have enough expertise in running the production affairs, and that is why three experienced people will be brought from the foreign country in order to supervise the production. Their monthly wage rate is assumed to be 18,000 Rand per person, subject to a real growth rate of 0.5% per annum. The management team will be employed full time from year 2003 to 2012. The South African personal income tax rate is 25%, and foreign employees are expected to repatriate 50% of their net-after-tax income back to the home country.

5.2.10 Operating Costs

There are a number of direct and indirect operating costs associated with the business. Transportation and storage expenses are estimated at 2.0 million Rand/year at the full plant capacity. Administration of the plant will be partially charged to an item of “office accommodation” of 1.2 million Rand/year, and also to “telecommunication” expense, estimated at 0.6 million Rand/year. Audit and accounting services are expected to cost 10.0 million Rand/year, while advertising is budgeted with 5.0 million Rand/year. Business travel and transportation expenses are expected to be 1.0 and 1.5 million Rand/year respectively. Office and transportation services will cost 0.5 million Rand/year. All the stated figures are expressed in the prices of year 2002, i.e. real prices. An inflation adjustment will be needed for the future projections in order to maintain the same price level in real terms.

Equipment mechanic service is the expense for routine equipment maintenance, which typically includes some spare parts and labor to maintain the machinery in a proper condition. It is estimated that this service will cost, on the average, 2.5% of the real total equipment cost every year. An adjustment should be made for the actual capacity plant utilization factor and inflation rate.

5.2.11 Electricity

The site of the feed production is located in the vicinity of Polokwane Municipality and electric power is supplied to the plant by Polokwane Municipality. A quote was obtained from the Municipality on the conditions and tariffs applicable for such a connection. A fixed service fee of 90 Rand/month, in real terms, is charged on the connection regardless of the actual consumption. It is expected that the plant will consume power of 200 KVA per month. A demand charge of 50 Rand/month, in real terms, is also applied on every KVA of energy consumed, in addition to the following tariffs. The basic tariff of 0.20 Rand/kWh is charged for the first 100,000 KWh per month, and a tariff of 0.18 Rand/kWh is charged for any energy above the 100,000 KWh/month consumption. It is assumed that the tariffs will grow by 0.5% per annum in real terms, in addition to the annual inflation adjustment.

5.2.12 Water

Water services are also provided by Polokwane Municipality, from which a quote was obtained in regard to water tariffs. A step tariff rate system is used by the Municipality with the first 30 m³/month being charged at 5.00 Rand/m³, the next 20 m³/month is charged 6.50 Rand/m³, the following 50 m³/month is charged 7.50 Rand/m³, the next 19,900 m³/month is charged 8.00 Rand/m³, and any amount above that is subject to a tariff of 7.00 Rand/m³. Due to scarcity of water in the region and raising costs of water provision, a real growth rate of 1.0% per annum is used in the analysis, in addition to the annual inflation adjustment of the tariffs.

The designed water consumption for the plant is 60,000 m³/annum if it operates at the full capacity. The actual water requirement in any year is calculated by multiplication of the 60,000 m³/annum water requirement and the actual plant capacity utilization factor in that year. For instance, the water requirement for year 2003 is only 30,000 m³ because the plant is expected to operate at 50% of its capacity.

5.2.13 Inventory of Feed and Feed Ingredients

The business of animal feed production requires input and output inventories in order to run smooth. An inventory of feed ingredients is needed to ensure an interruptible availability of raw materials, and to avoid frequent price fluctuations of the major ingredients, such as maize and oilcake. Feed inventories are desirable to be able to serve any potential customer. The amount of inventory is a choice of the management, and there is always a trade-off between the advantage of having a plentiful stock at any time and the opportunity cost of keeping such inventories in the working capital plus physical storage costs. A larger inventory implies higher opportunity and storage costs and that is why, hence, any increase in inventory will have a negative impact on the net cash flows of the enterprise. This will be reflected in increased purchases of inputs than actually used in production in order to build up the input inventories, and an excess of production over sales in order to accumulate the inventories of finished goods.

As experts from AFMA suggest, an “optimal” amount of raw materials inventory is a 2-month stock of feed ingredients. It is assumed that at the end of year 2002, a 1-month stock of feed ingredients needed for the operation in the next year will be purchased. During the period of 2003-2012, a stock of 2-months feed ingredients will be maintained. Because there is no need for any raw materials in year 2013, the ending stock in year 2012 should be zero.

Feed inventory is assumed to be a 3-week stock of manufactured feed in year 2002, while an active advertisement campaign will be in action, and a 2-week stock from 2003 to 2012 during the plant operational life. The feed inventory will still be a 2-week stock at the end of year 2012, and this stock will be sold off during the liquidation year 2013.

5.2.14 Depreciation

Any physical asset, with exception of land, tends to depreciate over years. The financial model of the project must account for the expected decline of the asset values, and a clear distinction must be made between economic and tax depreciation of assets. It is important to understand how the two types of depreciation enter into financial model.

Economic Depreciation

Economic depreciation is the physical process of aging of the equipment or any other asset, and it attempts to estimate the actual loss of value of the asset over the years. The specific function of economic depreciation is to estimate the salvage value, or also called “residual” value of assets, which is the market value of the asset for which it could be sold for at the end of the project. Economic depreciation aims at finding the liquidation value of the asset, which will be part of the liquidation proceeds at the end of the project life.

It is expected that the feed plant equipment and vehicles will have a useful economic life of 15 years, which means that at the end of 10 operational years there will be some residual value left. Also it implies that any equipment item depreciates at a rate of $1/15$ or 6.67% per annum. The construction assets, such as buildings and roads have a longer lifespan, and it is quite safe to assume a 30-year economic life for them. This implies a $1/30$ or 3.33% rate of annual depreciation, and there will be a residual value at the end of the 10-year feed project life. The project owners will have the option to recover the remaining value of the construction assets by selling the site and buildings at the end of the project.

Tax Depreciation

Tax depreciation is different from economic depreciation. The rate of tax depreciation per year is specified by the tax laws of the country. The purpose of tax depreciation schedule will be to estimate the amount of the tax depreciation expense that can be deducted from the taxable income. The tax laws around the world allow businesses to deduct a certain amount of tax depreciation expense, based on the historical cost of the asset. It is not necessarily that the rate of tax

depreciation follows the physical aging of an asset, and also certain restrictions are often put on the amount of depreciation expense for tax purposes, for example, in some countries it is possible to depreciate either more or less than the full purchase value of an asset. It is typical that the rates of tax depreciation are greater than the actual tear and wear of the company's assets. This is favorable for the business because more tax deductions are accumulated in the first years.

According to the current tax regulation in South Africa, the tax depreciation life for the equipment and vehicles of the feed plant is taken as 5 years, allowing the full 100% depreciation of the asset value. The rate of tax depreciation for equipment items is, therefore, $1/5$ or 20.0% per year, and after five years no further tax deduction is allowed. As we have seen above, the equipment's useful economic life is believed to be 20 years, but for tax purposes the whole cost of equipment can be deducted from tax income in just 5 years, which is much faster than the actual ageing of the assets. The tax depreciation rate in South Africa for the buildings and other permanent constructions is set at 5% per annum and it is applied on the 100% of the historical cost.

The "historical cost" is the share of the initial costs eligible to be depreciated for tax purposes. In certain cases, the tax code may allow the historical cost to be either more or less than the actual cost. In this particular case the amount of the assets that is paid for by the Government grant is deducted from the historical cost because this grant amount is not allowed to be depreciated for the tax purposes. The tax cost base is applicable only for tax depreciation, because it has nothing to do with the physical depreciation of the assets, captured in the economic depreciation. In the present case, all assets are allowed to use the 100% of their historical value for the calculation of the tax depreciation expense.

5.2.15 Investment Cost Overrun Factor

The investment cost overrun factor is a variable that represents the deviation in the actual investment costs away from the design cost estimates. It is a very common for the actual construction costs to rise due to unforeseen delays, technical difficulties or natural disasters. The investment cost overrun factor expresses the change in the planned costs as a percentage. If there is a positive deviation then the actual investment costs will increase, while a negative factor will mean that the actual costs are lower than expected.

The correct way to incorporate the investment cost overruns into the spreadsheet is to apply it on an existing value as an additional factor at the end of existing formula. For example, let's assume we have a cell with formula:

$$P_{\text{Nominal, YearX}} = P_{\text{Real, 2002}} * I_{\text{YearX}}^D$$

$$P_{\text{Nominal, 2003}} = 100 * 1.06 = 106$$

Where the nominal price of an asset in 2003 is estimated as 106 Rand (P_{Nominal}) by multiplying the 100 Rand, which is the real price of this asset in year 0 (P_{Real}), by 1.06, which is the domestic inflation index in year 1 ($I_{\text{Year1}}^D = 1 + \text{Inflation Rate}_{\text{Year1}}$), assuming the rate of inflation equal to 6.0%. This simply says that the expected price of this asset in year 1 will be the price in year 0 adjusted for the domestic inflation. If investment cost overrun factor is incorporated into the above formula, it should be added at the end of the formula:

$$P_{\text{Nominal, YearX}} = P_{\text{Real, 2002}} * I_{\text{YearX}}^D * (1 + \text{Investment Cost Overrun Factor})$$

$$P_{\text{Nominal, 2003}} = 100 * 1.06 * (1 + 0\%) = 106$$

In the base-case, this factor is set to zero meaning that the costs are not biased either upwards or downwards, and any change in investment costs is really unexpected. But any deviation from zero will change the formula's result.

This factor is later used in the sensitivity and risk analysis to test the viability of the project to unforeseen changes in the investment costs. The investment cost overrun factor should be used with a caution because it may not be reasonable to apply it on certain items, such as equipment, for instance. There are no unexpected changes in the prices of equipment once the project signs a contract with the supplier of equipment. Therefore, there should be no link to the investment cost overrun factor for the equipment items and also for the land. Only the construction costs and installation costs should be linked to this factor.

5.2.16 Maximum Grant Amount

This figure shows the maximum amount of grant that can be made available for a new project as a part of the investment incentives package by the National Government. According to the current regulations, SARS (2002), the maximum amount of cash grant is 3.0 million Rand to be given in two annual equal parts.

5.2.17 Feed Ingredients

A variety of plants and agricultural by-products can be used as inputs for feed production. This is an unrewarding task to enumerate all likely ingredients that can possibly be used in production. Instead, a more general approach is used, assuming that whatever the actual mix of ingredients is, the average cost of feed ingredients is 950 Rand₂₀₀₂/ton in year 2002. This figure is comparable with the feed ingredients per-ton-cost estimates, stated in interviews by different farmers around Pietersburg and by existing feed producers in Polokwane. The assumption is made that the average cost of feed ingredients will remain constant at 950 Rand₂₀₀₂/ton, in real terms, over the project's life. Later this assumption can be relaxed in the sensitivity and risk analysis.

The change in the cost of feed ingredients is a variable created for the sole purpose of testing the impact of cost changes on the project performance. What this variable does, is that it increases (decreases) the feed ingredients costs if the value of variable is set to be positive (negative), and it does not impact the ingredients costs at all if the variable value is zero. The mechanism through which this variable influences the actual spending will be described in detail in Sections 5.6–5.7.

Most of the feed ingredients have a high traded content, because maize and protein sources are internationally traded commodities and, therefore, a 50% share of tradable ingredients is assumed. Non-tradable feed ingredients account for 40% of the total cost while transportation and handling costs are assumed to be 8% and 2% respectively.

For the purposes of further economic analysis, assumptions must be made about the traded content in each of the components of ingredients are needed. Thus, the traded content of tradable ingredients is 100% because they are all internationally traded, while the traded content of non-tradable ingredients is assumed to be only 20% of their value, and traded content of transportation and handling costs are assumed to be 43% and 60% respectively. This detailed break-down of traded content is needed in order to estimate the composite traded content of feed ingredients. This is calculated as a weighted average of the cost shares and corresponding traded contents, and the resulting figure is 63.7%. In other words, the total composite traded content of feed ingredients is, on the average, 63.7%.

5.2.18 Milling Fee

The milling fee is the average real fee that must be charged per ton of feed in order for the plant to break-even financially, i.e. to have the NPV of zero in the owner's evaluation perspective.

In other words, this is the minimum milling fee that the plant must charge the customers per ton of feed. The following equation holds true:

$$\text{Price of Feed} = \text{Cost of Feed Ingredients} + \text{Milling Fee}$$

The minimum milling fee shows how efficient this plant can be compared to other producers, and if there are any economies of scale that help to reduce the overall production costs. Assuming that all feed manufacturers face the same input costs and any individual producer is a price-taker, then the ability of a plant to charge a higher milling fee means higher profits and greater flexibility to lower its price tags, if needed.

Thus, for an individual producer, the break-even price of feed is a direct function of the ingredients cost and milling fee. Any change in either of them should immediately translate into a price movement. An implication of this fact is that the price of feed becomes an endogenous variable, determined within the model. The two exogenous variables are the average feed ingredients cost and average milling fee. In this case, we first want to know the value of milling fee at which the project breaks-even, meaning that the net present value of the cashflows from owner's point of view is zero. In other words, the enterprise just covers all the investment and operating costs, including the opportunity cost of capital.

Finding out the break-even point, which sets owner's NPV to zero is an iterative process, which can only be done after the financial model is complete and owner's NPV is calculated. An Excel's function, called "Goal Seek" is used to set the owner's NPV to zero by changing the value of milling fee in the Table of Parameters. The resulting break-even value of the milling fee is 258.2 Rand₂₀₀₂/ton, and it is assumed to remain constant at this level, in real terms, over the project's lifespan in the base-case financial analysis. Thus, the average price of feed from the plant is calculated as 1,208.2 Rand₂₀₀₂/ton, which is a sum of the average cost of feed ingredients and milling fee.

The change in the milling fee is another variable, specially designed to trace the effect of changes in the fee on the project performance. The value of this variable in the base case is zero, meaning that no change is expected to the milling fee. Any deviation from zero is translated into consequent effects on the price of feed, which should either rise or fall, but because the project is said to be a price-taker then the ultimate impact will be on the quantity of feed sold, rather than the price. The exact way of modeling this effect is described in Sections 5.6–5.7.

5.2.19 Feed Production

A number of parameters are used to describe and model the feed production. Typically a single plant is able to manufacture different types of animal, aqua-feed and concentrates. It is also a safer business strategy to diversify production by manufacturing feed for different animal and feed of assorted dietary content. It is expected that the plant will produce feed for cattle, milk cows, layer chicken, broiler chicken, pig feed, game feed and aqua feed. There could be also different kinds of feed for the same animal, for example cattle feed can be formulated to support the nutritious needs for each of the different stages of animal growth.

Faced with this variety of possible options, an analyst may find it difficult to be as precise in projecting the future as he otherwise wants to be. It is impossible to foresee in advance what will be the actual production mix of the different feed types during the 10-year life of the project. But what is possible to do is that the analysis can be still carried out without sacrificing much of the desired precision by making reasonable assumptions, based on the current observations and market trends.

It is assumed that 30% of the feed production will be for cattle and milk cows, which are the commonly bred animals in Limpopo Province. Other feed manufacturers also seem to have a big portion of production in this type of animal feed. Since the actual mix of ingredient varies with the type of feed, season of the year, current market prices, the average cost of raw materials for beef feed is taken as 1,035 Rand/ton. The chicken layer feed and broiler feed are assumed to occupy 15% each in the total production of the plant. Their respective average ingredients costs are 1,096 and 1,046 Rand/ton. Pig feed is given a share of 15% in the total production, and its average raw materials cost is taken as 894 Rand/ton. A lucrative and growing market in Limpopo Province is the game feed for wild animals held in game reserves. This feed is often used to supplement animals' ration in the summer and to feed them in winter, when natural grazing might be scarce. The average ingredients cost is assumed to be 743 Rand/ton, a figure consistent with information obtained from interviews with the existing game feed manufacturers. Aqua feed is another potential market niche, and the management of the project thinks that it is a direction they should go. The aqua feed is easier to transport, and competition is less fierce, compared to other feed types. The aqua feed is given a 5% share in the total production, and its raw materials cost is taken as 778 Rand/ton.

A number of feed types that this plant can manufacture are not, in fact, limited to the mentioned above. The other possible types include sheep feed, feed for ostriches, feed for rabbits, and so on. Again, it is impossible to foresee the actual combination of the production mix over the project life, and that is why it is reasonable to limit the analysis to the selected feed types, which are definitely going to be marketed.

5.2.20 Feed Prices

The price for each type of feed is calculated as a sum of its average ingredients cost and the milling fee. For instance, the 1,366 Rand/ton price of chicken layer feed is a sum of its raw materials, worth 1,096 Rand/ton, and the milling fee of 270 Rand/ton. The prices of the other feeds are calculated in exactly the same way, reflecting the fact that the price is a direct function of the raw materials cost and milling fee.

A weighted average cost of ingredients is calculated to cross-check the actual cost of the raw materials in the production mix. The weighted average calculated as a summation of each feed's production share times its ingredients cost:

$$C_W = \sum_{\text{FeedM}} (\text{Production}\%_{\text{FeedM}} * \text{IngredientsCost}_{\text{FeedM}})$$

The value of the weighted average cost of ingredients must be equal to the parameter of the ingredients average cost, otherwise the feed prices will deviate from the expected levels, and the relationship identity between the feed price, input costs and milling fee will not hold.

The weighted average price of feed is also computed by using a similar formula, applied on the calculated feed prices:

$$P_W = \sum_{\text{FeedM}} (\text{Production}\%_{\text{FeedX}} * \text{Price}_{\text{FeedM}})$$

The weighted average price of feed, derived from the formula above, is 1,220.1 Rand/ton, which is simply the average cost of feed ingredients plus the milling fee.

5.2.21 Feed Market Parameters

Own-Price Elasticity of Demand for Feed

For the purpose of financial and economic modeling, a set of assumptions must be made about the feed market in the Province. The very first target is to determine the value of the composite

demand elasticity for feed (η_{Feed}). A few methods can be used to derive this parameter, using both direct and indirect ways to estimate the demand elasticity for animal feed. The direct approach would use data on feed consumption on the farms and fit the actual data into an econometric model; much like Tabeau (2001) did for the Netherlands. The problem with this approach is that it requires a detailed set of data from the farms on their feed consumption and such data may not be readily available. Given the fact that there is no data or primary study done in this respect for South Africa, the analysis should turn to an indirect way to estimate the own-price demand elasticity for animal feed.

The animal feed can only be used as an input into the meat production and the demand for feed really depends on the requirements by meat producers. Therefore, the demand for feed is a derived demand from the demand for meat by final consumers. As a consequence, in order to pursue this approach, the analyst should first obtain the value of the composite demand elasticity for meat with respect to its price.

The composite demand elasticity for meat (η_{Meat}) is a parameter describing the responsiveness of the consumers' demand for the meat to the meat price changes, as a composite commodity, which consists of beef, chicken, pork, lamb and other meats. The reason for introducing such a variable into the model is that the fact that the major driving force behind the feed demand is the use of feed as an input for the meat production.

A number of econometric studies have been done on the estimation of the demand elasticity for meat in various countries. Thus, Hanarahan (2002) finds on the example of Ireland that all the meat goods are net substitutes. The own-price Marshallian elasticities are estimated as -1.52 for beef, -0.49 for pig meat, -0.67 for poultry, and -0.61 for sheep meat. He also concludes that all the meat goods are normal goods. Mbala (2002) in the article on the short-run demand for goat meat in Cameroon finds that the own-price demand elasticity for goat meat is -0.85 if estimated by a linear function, and -0.90 if estimated by a double-log function.

A study by CARD (1987) reported the own-price elasticities for all meat and dairy products being between -0.97 and -1.05 in Indonesia. A report by Feuz (2002) states that previous national research in the beef industry had estimated the own-price elasticity of demand for beef at -0.60 in the United States. In a case-study of the pork import demand elasticity for Japan, Fabiosa and Ukhova (2000) estimated that own-price Marshallian elasticity of the demand for domestic meats was -1.11 for beef, -0.75 for pork, and -1.08 for poultry. Another paper by Workman, Kings, and

Hooper (1971) carried out research on the US beef demand in 1947-1967 and concluded that own-price elasticity of demand for beef during that period was -0.67.

Faced with a lack of micro data on the meat market in South Africa, a seemingly reasonable figure for the composite own-price elasticity for meat demand of -1.0 is used, which is consistent with the international estimates. To explore the stability of the project performance to having the meat demand elasticity different from unity, sensitivity tests are carried out in Sections 5.16.16–5.16.17 and 7.5.7.

The share of feed cost in the meat production (α_{Feed}) is yet another variable, which can be a subject of debate, given the fact that different animals have different consumption of feed, and shares of the feed cost in the total meat production costs are not the same. Ekermans (2001) states that South African beef producers have feed costs as much as 80% of their total costs. But an article in AFMA Matrix (2000) has a different assessment of the feed share in meat costs, and says that feed costs are a 50-60 % variable component of the total operating expenses on most dairy or feedlot enterprises. Thus, the present analysis assumes a 60% share of feed costs in the total costs of meat production.

Looking at the feed as a composite item, comprising all types of feed, reveals that there hardly is any other substitute for the feed input in meat production. This means, that the meat producers should have an inelastic demand for animal feed, treated as a composite item. The following relationship between output and input price elasticity of demand holds true for any commodity:

$$\eta_{\text{Feed}} = \eta_{\text{Meat}} * \alpha_{\text{Feed}} + \beta_{\text{Feed / Other inputs}} * (1 - \alpha_{\text{Feed}})$$

Where the demand elasticity of feed (η_{Feed}) is equal to the summation of the demand elasticity for meat (η_{Meat}) times the share of feed costs in the meat production (α_{Feed}), with the substitution elasticity of the feed for other inputs ($\beta_{\text{Feed/Other inputs}}$) times the share of all the other inputs in the meat production ($1 - \alpha_{\text{Feed}}$). Thinking over this identity leads to a conclusion that, given the fact of zero substitution between the composite feed input and any other inputs ($\delta_{\text{Feed / Other inputs}} = 0$), it is possible to estimate the composite demand elasticity for feed (η_{Feed}) by inserting the known parameters into the identity:

$$\eta_{\text{Feed}} = -1.0 * 60\% + 0 * 40\% = -0.6$$

The resulting demand elasticity for feed is -0.6, which conforms to the prior expectation of it being an inelastic parameter, since the meat producers have really no other substitute for feed as an input.

Elasticity of Supply of Feed by Other Producers

The supply elasticity of feed by other producers is also a variable giving room for the analyst's judgment. Given the lack of research on the quantities estimates of the animal feed market parameters, it is the task of this study to find an appropriate figure for the purpose of the analysis. What is observed on the existing feed market in Polokwane, and was also confirmed in interviews with the feed manufacturers, is that if the feed producer sees a real (inflation adjusted) increase in the price of feed, with the cost of inputs remaining constant, he will be willing to expand the production very fast. The feed manufacturing equipment can be used in almost a 24-hour cycle and workers can be organized in shifts, if the plant faces an extra demand for its products. Placing a numeric value on this variable is not easy, but keeping in mind that consequent sensitivity tests can re-calculate the project results under different assumptions for this variable, a figure of 5.0 seems to be a reasonable guess about the true value of the feed supply elasticity of other feed manufacturers in Limpopo Province.

The share of ingredients in the total cost of feed, estimated as 0.88, is actually computed by dividing the present value of feed ingredients costs by the present value of total investment and operating costs. Such an operation will be possible only at the end of the financial model, and Table 64 can be used for this purpose. Section 6.4.20 describes the modeling of that particular table in detail.

It will be useful in the later financial analysis to measure the impact of a change in the cost of ingredients on the demand for feed and, hence, production. The share of milling costs in the total cost of feed is the proportion of the present value of the sum of all other costs except than the feed ingredients to the present value of the total costs, or it can also be found by subtracting the share of costs of ingredients in the feed from unity ($1 - 0.88$), since the sum of the two shares must add up to one by definition.

The provincial production of feed by other manufacturers is an estimate of the quantity of the feed supplied to the market. The quantitative assessment was done in DFED (2000) and it indicated that approximately 400,000 tons of animal feed were produced in Limpopo Province in year 2000. This figure, however, seems to underestimate the actual production because it does not account for small farmers and alike. Also it does not take into consideration the provincial cross-boundary movements, which is likely to reveal, if it was possible to trace, that the net provincial feed imports are greater than feed exports to other provinces.

Since the provincial production estimate was done in year 2000, an adjustment is needed to approximate the quantity of feed being currently manufactured in the Province. For this purpose, an average national growth rate of feed sales is introduced into the model. AFMA has kept exceptionally good historical records of the feed sales in South Africa, and the past growth rates can be derived from the report by Griessel and Bekker (2000). The average growth rate for years 1981-1999 was estimated as 2.8% per annum. However, this rate is actually based on the sales of AFMA members only, and does not include the manufacturers who are not associated with AFMA. For the application of the growth rate on the provincial production, it is fair to use a projected growth rate of 3.0% for feed sales, in order to counter-balance the shortcomings mentioned above. Thus, a growth rate of 3.0% is actually used in the analysis.

The weights on the supply and demand of feed are the estimated responses of the existing feed manufacturers and consumers to the plant's production. Given that the feed market is not regulated by the government and the forces of demand and supply determine the quantity and price of the feed sold, any additional production will have an impact on the current equilibrium. The weight on supply parameter attempts to estimate the degree of such an impact on the existing feed producers in Polokwane, and it can be expressed as the other producers' supply elasticity of milling ($\epsilon_{\text{Milling}}^{\text{Others}}$) over the sum of the other producers' supply elasticity of milling and composite demand elasticity for feed (η_{Feed}):

$$\text{Weight on Supply (Ws)} = \left| \frac{\epsilon_{\text{Milling}}^{\text{Others}}}{\epsilon_{\text{Milling}}^{\text{Others}} + \eta_{\text{Feed}}} \right| = \left| \frac{5.0}{5.0 - 0.6} \right| = 0.89$$

The remaining response to the plant's production, therefore, falls on the demand side of the feed market, and it represents new, induced, consumption. The correct way to estimate this parameter is to replace the nominator of the previous formula with the other producers' supply elasticity of milling:

$$\text{Weight on Demand (Wd)} = \left| \frac{\eta_{\text{Feed}}}{\epsilon_{\text{Milling}}^{\text{Others}} + \eta_{\text{Feed}}} \right| = \left| \frac{-0.6}{5.0 - 0.6} \right| = 0.11$$

It is useful to think of these weights as of the market response to a new project's production: some of the response would be a cut-back from the existing manufacturers, and the other portion would be the induced consumption. What is also true is that the estimated weights must add up to unity ($Ws + Wd = 1$), by definition. The computed weights will be used in the estimation of the

production forgone by the existing feed manufacturers, and also in the estimation of the economic cost of feed.

5.3 Table of Inflation Rates, Price Indices and Exchange Rate

Having a complete Table of Parameters allows the analyst to start modeling the financial profile of the project. The most logical thing to start with is the Table of Inflation Rates, Price Indices and Exchange Rate, because all other tables will need the nominal prices and/or exchange rates. A typical Table of Inflation Rates, Price Indices and Exchange Rate is shown in Table 2 in Annex A, and it consists of the inflation indices of the currencies involved and the exchange rate(s) projections for the future.

The feed project is financed by two currencies, the US dollar and South African Rand. However, if more currencies are used then their inflation rates and price indices should be included in the same manner as described here. For simplicity, it is useful to assume that the inflation rates are the annual averages, but the exchange rates and price indices are the figures at the end of the year.

5.3.1 South African Rand

The first line of the table is the projected inflation rate of the South African Rand (domestic currency), which takes on the values stated initially in the Table of Parameters. As already mentioned, the average annual inflation rates are 6.0% for year 2000, 12.0% for year 2001, 9.0% for year 2002, and a rate of 6.0% is the expected average rate of inflation for the years 2003 onwards. Note that all the values in this table are “linked” to the Table of Parameters, and there is no “typed” number. A failure to “link” the variables to the Table of Parameters will result in the model being handicapped by the loss of relationship between the exogenous variables, i.e. inflation rate in Table of Parameters, and the model’s outcomes.

Note that apart from having a direct link to the Table of Parameters, each year inflation rate contains a factor for the “disturbance to the South African inflation rate” and modeled as:

$$i_{\text{YearX}}^D = i_{\text{YearX (from Table of Parameters)}}^D * (1 + \text{Disturbance to SA Inflation Rate}_{\text{YearX}})$$

$$i_{2003}^D = 6.0\% * (1 + 0\%) = 6.0\%$$

Where, the domestic inflation rate in year 2003 (i^D_{2003}) already incorporates a factor, which will account for unexpected changes or “disturbances” in the inflation rate in 2003. This “disturbance to the South African inflation rate” is a special risk variable introduced into the model for the purpose of risk analysis. This variable represents all possible forces affecting the projected inflation rate of 6.0%, and these forces might be caused by unexpected domestic and international events such as political and social crisis, war, terrorism, capital flight, etc.

In the base-case of the analysis, this variable is set to zero for every year of the project’s operation indicating that, on the average, there is no expectations of the inflation rate to be different from its long-run average rate of 6.0% per annum. The risk analysis software Crystal Ball[®], developed by Decisioneering, Inc., will generate a random disturbance factor in every year of the project’s life, according to the specified probability distribution, based on the past and expected inflation rate movements. Section 8.1.1 explains the way such a probability distribution is derived.

The domestic price index is a computed index, which accounts for all accumulated inflation since the year zero, year 2002. This index simply shows by how much the general level of prices has risen since the beginning of the project. The way this index is computed allows for the integration of both the expected inflation rate as well as the annual disturbances to it. The formula describing this relationship is:

$$I^D_{\text{YearX}} = I^D_{\text{YearX-1}} * (1 + i^D_{\text{YearX}})$$

$$I^D_{2005} = 1.12 * (1 + 6\%) = 1.19$$

Where the price index of the current year (I^D_{2005}) is calculated as a product of the previous year’s price index (I^D_{2004}) times the factor for this year inflation rate (i^D_{2005}). Since the current inflation rate already includes the uncertainty factor, the above formula is flexible enough to include the expected 6.0% rate of inflation as well as an element of uncertainty.

The future forecast of the real cost of inputs can be done on the assumption of an increasing, declining, constant or a non-linear trend for the variable in question. If a cost of input, in real terms, is expected to remain constant throughout the project life, let’s say $C_{\text{nominal}} = 100 \text{ Rand}_{2002}$, then the nominal cost of this input in any given year is computed as a product of its real cost in year zero prices times the current domestic inflation index in year X, $I^D_{2005} = 1.19$:

$$C_{\text{Nominal, YearX}} = C_{\text{Real, 2002}} (\text{Rand}_{2002}) * I^D_{\text{YearX}}$$

$$C_{\text{Nominal, 2005}} = 100 * 1.19 = 119 (\text{Rand}_{2005})$$

This is a simple and convenient way to model the annual inflation increases. It should be kept in mind that the year-zero price index is always unity, because the prices of this year are taken as the starting point for further analysis. In fact, it does not matter which year is chosen to be the starting point of the project, as long as all consequent analysis discounts the project benefits and costs back to the same date in a consistent way.

5.3.2 US dollar

The US-dollar annual inflation rates are modeled in the same way as the domestic inflation rates, taking into account the disturbance factor for the US dollar. The US-dollar price index follows an identical modeling procedure to the one used for the South African Rand above. If a project has to deal with more than one foreign currency then an additional set of variables consisting of a price index, annual inflation rates, and disturbances to them are needed.

5.3.3 Exchange Rates

Exchange rate modeling is needed to convert any dollar-denominated cashflows into domestic currency. Because all the financial statements and cashflow projections are typically done in the domestic currency, any foreign revenues or expenses will have to be translated into their domestic equivalents in a consistent way. The methodological framework of consistent modeling of price indices and foreign exchanged rates is outlined in Chapter 4 of the *Manual (2003)*.

A few facts are useful to remember at all times. The foreign exchange rate, no matter how “stable” it may seem, is also subject to forces of the relative inflation rates of the two countries, which must be reflected in the exchange rate projections. It is very common around the world to express the value of certain goods in US dollar, or other “hard” currency to avoid frequent re-labeling price tags due to domestic inflation. While this tactics is useful for such purposes, the US dollar as any other currency also is subject to its own rate of inflation, which has in the recent years been relatively modest as compared to inflation rates in some developing countries. It is also necessary to express the equilibrium nominal exchange rate as a function of the price levels between two countries, despite the fact that many other forces may influence the real exchange rate. The changes in the exchange rate can be said to consist of the interaction of the two inflation rates and a composite impact of all other factors. To keep analysis simple and manageable, it is useful to assume that the real exchange rate remains, on the average, constant throughout the

project life. If more information on the real exchange rate movements over time is available, then the analyst will want to incorporate such expected real exchange rate adjustments in the model.

The relative price index is a measure of the domestic price index in terms of the foreign price index, calculated as:

$$I^{D/F}_{YearX} = I^D_{YearX} / I^F_{YearX}$$

$$I^{D/F}_{2005} = 1.19 / 1.08 = 1.11$$

This relative price index is a convenient way to express the cumulative price changes in both currencies, since the beginning of the project. If the domestic price index has been changing faster than the foreign price index, i.e. the domestic inflation rates have been higher, then the relative price index will tend to increase, while a lower domestic inflation, compared to foreign inflation, will lower this index. The index is ultimately used in the estimation of the nominal exchange rate.

The real exchange rate parity between the South African Rand and US dollar is assumed to remain constant at the 11.7 Rand/US level of year 2002, which is defined as year-zero for the project. Note that the 11.7 Rand/US rate has also been estimated, since this study is being done before the end of year 2002 and the end-of-year exchange rate is unknown. The correct way to estimate the end-of-year 2002 exchange rate is to take the end-of-year 2001 exchange rate of 11.0 Rand/US and to multiply it by the relative inflation rate during year 2002:

$$E^{Real}_{2002} = E^{Real}_{2001} * \frac{(1+i^D_{2002})}{(1+i^F_{2002})}$$

$$E^{Real}_{2002} = 11.00 * \frac{(1+9.0\%)}{(1+2.5\%)} = 11.70$$

This formula is based on the previous year exchange rate (E^R_{2001}) and it takes into account the domestic (i^D_{2002}) and foreign inflation (i^F_{2002}) during the current year. Note that only in year-zero will the nominal prices and exchange rates be equal to their real counterparts, simply because this year is taken as the base year for the analysis. All consequent years will have an inflation wedge between their real and nominal prices. Once the real exchange rate at the end of year 2002 is estimated then it is assumed to remain constant for the rest of the project's life. The line with the real exchange rate has the same value for all years. The advantage of showing the fixed real exchange rate explicitly is that the analyst has the choice of relaxing the assumption of constant real exchange rate, in order to test the sensitivity the project to changes in the real exchange rate.

The next step is to estimate the “unadjusted” nominal exchange rate, which is simply a product of the real exchange rate in a certain year and the corresponding relative price index of the same year. This relationship can be expressed as:

$$E_{\text{Unadj}}^{\text{Nominal}}_{\text{YearX}} = E^{\text{Real}}_{\text{YearX}} * I_I^{\text{D/F}}_{\text{YearX}}$$

$$E_{\text{Unadj}}^{\text{Nominal}}_{2004} = 11.70 * 1.07 = 12.51$$

This formula estimates an “unadjusted” nominal exchange rate, i.e. an exchange rate not including any other factors except the inflation rates. An “adjustment” should be made to this exchange rate in order to incorporate the likely impact of exogenous factors affecting the determination of actual market exchange rates.

It is a convenient way to treat all uncertain forces as a “disturbance” factor, which is really a composite sum of all these impacts on the exchange rate. Given that the analyst has no prior knowledge about these unforeseen forces, the base-case disturbance variable is set to zero, meaning that the expected value of such a disturbance is zero. The risk analysis software will assign a random factor each year, according to the probability distribution specified and Section 8.1.2 deals with this task. For the purpose of the financial analysis, the disturbance factors should be zero, as shown in Table 2. The “adjusted” nominal exchange rate is based on its unadjusted rate but it incorporates the disturbance factor, as follows:

$$E_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} = E_{\text{Unadj}}^{\text{Nominal}}_{\text{YearX}} * (1 + \text{Disturbance to Real Exchange Rate}_{\text{YearX}})$$

$$E_{\text{Adj}}^{\text{Nominal}}_{2004} = 12.51\% * (1 + 0\%) = 12.51\%$$

A final note here is that in a situation where the project has to deal with more foreign currencies, the model should have a separate set of relative price indices with that currency, real exchange rate as well as an unadjusted and adjusted exchange rate. This will ensure the consistency in the financial modeling of the project’s cashflows.

5.4 Table of Investment Costs

Having estimated the movement of the domestic price level and market exchange rates over the project’s lifespan, the analyst can now start with the specification of actual cashflows of the project. The most common approach is to start with a Table of Investment Costs, which are the first cash outlays for the business. A typical Table of Investment Costs is presented in Tables 3A–3H in Annex A, which shows the data on the initial capital expenditure of the feed plant. As it is easy to notice, the Table is long and seemingly complex, which would be probably true for any project

having good data set on the investment costs. The feed project has a detailed set of itemized cost estimates because its foreign counterpart plant was built in the same way. The total investment expenditures can be broken down into several categories: land, construction, feed production equipment, office equipment and vehicles. The land, construction costs, office equipment and vehicles will be purchased with the South Africa Rand, but most of the equipment and its freight costs will be paid for in US dollars.

5.4.1 Land

The land is already purchased by the foreign investor in Polokwane. The purchased plot of land is actually a much larger area than needed for the feed plant. The investor wanted to have spare space to be able to place any other of his future activities in the same location. The total amount spent on the land was 7.0 million Rand in year 2002. The feed production is going to occupy only about 1/6 of this area, and the project analyst should have a clear understanding how to treat the land in this case. Since the feed plant will be using only a portion of the available land while the rest will be associated with other project(s), then the true value of the resource used by the feed plant is only 1/6 of the total cost, and not the full cost of the plot. For the purpose of the analysis, a figure of 1.2 million rand is used as the land cost for this project. Since this is an asset for which the investor already fully paid, no investment cost overruns are expected for this item.

5.4.2 Construction Costs

A few buildings have to be constructed, including the factory, warehouse, raw materials warehouses, weight bridge, roads and various auxiliary structures. The full list of the items of the construction costs are shown in the Table 3A in the Annex A. Note that a quote on the construction costs was obtained in year 2001, and an adjustment for the inflation must be made in order to bring the 2001-cost estimates to the price level of year 2002, year-zero in the analysis. It is often the case with construction activities that there could be time and/or cost overruns, and the project model must make a provision for such events. What it really means is that both time and cost overruns can be expressed as a percentage deviation from the planned construction budget, because even time delays imply business losses. Thus, the analyst should incorporate both the inflation adjustment and provision for investment cost overruns in the estimation of the construction costs of year 2002. The formula, which is capable of doing that, can be spelled out as:

$$C_{ItemM}^{Rand}_{2002} = C_{ItemM}^{Rand}_{2001} * (1 + i^D_{2001}) * (1 + \text{Investment Cost Overrun Factor})$$

Knowing the actual circumstances of the project helps the analyst to make the right estimates of the value for the variable. The question of whether to use the inflation rate of year 2001 or 2002, can be resolved by knowing that the construction cost estimate was done at the beginning of the year 2001, and actual construction of the plant takes place in the mid of 2002, which can be best modeled with inflation rate of year 2001, not of 2002 because the construction starts before the end of 2002. Let's take the estimate of the construction cost of the workshop, and show that:

$$C_{\text{Workshop}}^{\text{Rand}_{2002}} = 2,775,386 * (1 + 12.0\%) * (1 + 0\%) = 3,108,433 (\text{Rand}_{2002})$$

The cost of workshop in year 2001 (C_{2001}) is adjusted for the inflation rate, and an additional factor, describing the net effect of time/cost overruns from the Table of Parameters. In the base case this factor is zero, meaning that no overruns are expected, but this parameter will be changed in order to test the model's responsiveness to this parameter in the consequent sensitivity and risk analysis.

5.4.3 Office Equipment and Vehicles

In the 2001 application submitted by the investor for the grant incentives, the cost estimate for the office equipment and furniture totaled to 946,000 Rand₂₀₀₁. The budget for vehicles was stated as 400,000 Rand₂₀₀₁. These figures must be inflated to the price level of year 2002. No investment cost overruns are expected for these two items.

5.4.4 Freight and Traveling

This section describes the costs of international and domestic freight of the equipment, insurance, and traveling expenditures for the personnel transfer from the foreign country. The freight cost estimates are taken from a quote obtained from international and domestic carriers in 2001. The international costs are paid in US dollar, and all local expenses in Rand. No investment cost overruns are generally applied on such expenses.

The US-dollar expenses include the freight and statutory costs for machinery and equipment as well as for certain imported raw materials. Another dollar expense is for the international travel of the personnel. The column with total US-dollar expenses in year 2001 totals these expenditures but further adjustment is needed in order to arrive at the price level of the year 2002. As mentioned above, the US-dollar prices are also subject to inflation and the correct way to model this is to inflate the past costs by the accumulated inflation (price index) of the US dollar. Since it is only

one year difference between the 2001 cost estimates and the 2002 project's year-zero, then only the adjustment is the US inflation rate for year 2001. For instance, the 2001 quote for the freight of the machinery, equipment and raw materials is 252,500 US\$₂₀₀₁, and then its year-2002 equivalent is computed as:

$$C_{\text{Freight}}^{\text{US\$}}_{2002} = 252,500 * (1 + 3.0\%) = 260,075 \text{ US\$}_{2002}$$

Thus, the required adjustment is made to include the US-dollar inflation of 3.0% in year 2001. The same procedure is done for the traveling and statutory costs and their combined total, in real US-dollar terms, is worked out at the bottom of Table 3A. At this point, a conversion of this US-dollar total into Rand value is not needed, because this can be done in the summary of the total investment costs later, as shown in Table 3H in Annex A.

The Rand costs of freight and traveling include local transport, offloading, agency charges, insurance and VAT charges, and they are all grouped under the title of "local costs". Again, their values were taken from a 2001 quote and they have to be inflated to their 2002-year price level. Thus, the 2001-Rand total of local costs for machinery, equipment and raw materials is 56,500 Rand₂₀₀₁, which has to be inflated by 12.0% of the 2001 year inflation rate in order to arrive at the value of 63,280 Rand₂₀₀₂, at the year-zero prices. The same computation is performed for the insurance and VAT charges. The total Rand requirements, in real terms, are stated at the bottom of Table 3A.

5.4.5 Equipment

Tables 3B–3G contain a detailed account of equipment items, and that is why these tables seem to be lengthy and complex. All equipment and machinery can be, in fact, divided into four groups: raw material, drying and storage equipment; feed production equipment; feed briquetting process equipment; and electronic and internet control system. There are sub-sections under most of the groups:

Raw Material, Drying and Storage Equipment

- Section of Raw Material, Drying and Storage

Feed Production Equipment

- Section of Raw Material, Receive and Receiving Sieve
- Crush Section
- Dispensing and Mixture Section
- Pelletize Section

- Package Section
- Assistance Section

Feed Briquetting Process Equipment

- Assistance Section

Electronic and Internet Control System

- Weak Current Engineering and Internet Control System
- Electrical Machinery Control Centre (MCC)
- Work Field Material

This is the order in which these equipment items appear in Tables 3B-3G in Annex A. All the equipment items are modeled in the same way, and instead of describing them section by section, it could be more efficient to focus on the columns, which are somewhat complex to model.

Item and Description

Each item of the equipment and machinery has an order number according to the specifications of the plant, as stated in the grant application by the investor. The item's description and technical specifications follow that, and these can be useful for anyone who is looking at the project from technical view. The next column contains the number of units of a certain item to be used on the feed plant.

The power requirements in kWh per unit and total for an item are stated in the following two columns. A grand total of all power requirements will be done in the “summary” of the investment costs for the purpose of estimating the total energy demand by the plant and electricity expense.

Prices and Grant Eligibility

Total US\$₂₀₀₁: The original prices of all equipment items were obtained from a 2001 quote, and this is the figure placed in the US-dollar “price per unit” column. Since some of the items are used in multiple instances, a column with a total amount is needed, which is simply a product of the 2001 US-dollar price and number of units used.

Note that even if all equipment costs are stated in US dollar terms, some of the actual spending will be done in Rand, because certain items are available locally, or they represent local costs. Generally they are stated at the very end of each equipment section, and namely are the mounting and debugging costs, assist and mount materials, electric control costs. Because of this fact that the mechanical items and equipment are imported and paid for in US dollar, while the local costs are covered from Rand fund, a separation is needed to keep track of the total foreign and local expenses.

Thus, following the column with the US-dollar 2001-priced total there are three more columns, which are: the total expense for an item expressed in year 2002 Rand; a total expressed in year 2002 US dollar, and amount of grant eligible expenses expressed in year 2002 Rand. Each column serves its function in further analysis.

Total Rand₂₀₀₂: The column with the total expense for an item, expressed in year 2002 Rand, will be needed to find the total expenditures in the investment costs. Because the cashflows are generally reported in the domestic currency, all the imported items must be converted in their Rand equivalents. Also, since the US dollar cost estimates are given in year-2001 prices, an adjustment must be made to bring these costs up to the level of year 2002 prices. A formula, which serves both these tasks, is:

$$C_{ItemM}^{Rand}_{2002} = C_{ItemM}^{US\$}_{2001} * (1 + US\ Inflation\ Rate_{2001}) * E^{Nominal}_{2002}$$

What this formula does, is it starts with the year-2001 dollar cost of an item, then it inflates the cost by year-2001 foreign inflation, and finally converts the result into Rand by applying the nominal exchange rate of year 2002. An illustration of this can be shown on the “blanking die and granular membrane”, order item #101:

$$C_{Die\ and\ Granular\ Membrane}^{Rand}_{2002} = 4,395.24 * (1 + 3.0\%) * 11.70 = 52,956\ Rand_{2002}$$

The final year-2002 Rand value is the cost of the “blanking die and granular membrane” in year-2002 prices, which can be used in further calculations. Note that there is no investment cost overrun factor in the above formula. Each equipment item is processed in an identical way, and a sub-total is computed beneath of every section. The feed production equipment as well as the electronic and internet control system both comprise of many sections also contain grand-totals to summarize the results from every internal section. The summary of investment costs table will include all the costs of equipment items.

Total US\$₂₀₀₂ Costs: This column is needed to show explicitly what are the actual expenses made in US dollar, and what is the total requirement for US-dollar funds per item. It excludes all locally made expenses such as the mounting and debugging costs, assist and mount materials, electric control costs. The formula used to derive the year-2002 US dollar value from its year-2001 dollar cost quote is similar to the previous formula, except that it stops short of applying the exchange rate:

$$C_{ItemM}^{US\$}_{2002} = C_{ItemM}^{US\$}_{2001} * (1 + US\ Inflation\ Rate_{2001})$$

$$C_{Die\ and\ Granular\ Membrane}^{US\$}_{2002} = 4,395.24 * (1 + 3.0\%) = 4,527.1\ US\$_{2002}$$

Continuing with the example of the “section of raw material, drying and storage”, which is the only section under “raw material, drying and storage equipment”, the US-dollar requirements is stated for each item, except the very last articles of electrical control, mounting and debugging cost, and other mounting material. These three items are to be expensed in Rand and are, therefore, excluded. A total is computed for every section.

Grant Eligible, Rand₂₀₀₂: The purpose of this column is to show explicitly the items, which costs are eligible to be included into the calculation of the basis for the grant. There are a number of criteria, regulating the foreign investment incentives scheme, and according to them, only the foreign costs of equipment are to be included into the base. International freight and transportation expenses are also eligible, while domestic transport expenses are not. All the foreign costs have to be expressed in their Rand equivalent.

The current regulation states that the amount of grant is the minimum of either 3.0 million Rand, or 15% of the total grant eligible expenses³. The application for grant has been approved has been approved, and for the purposes of the present analysis it is needed to find the total amount of the grant eligible expenses.

The grant eligible column in the equipment and machinery costs simply shows the Rand year-2002 value of an item, if the item is allowed to enter into the grant-base calculation. All items of equipment are included, except the expenses such as the electrical control, mounting and debugging cost, and other mounting material. At the end of each section, a total amount of grant eligible expenses is calculated.

Share of Costs and Conversion Factors: The last few columns are needed for the estimation of economic conversion factors (CFs). Since these economic conversion factors don't have anything to do with the financial analysis yet and the analyst may like to shift the calculation of the investment items' CFs down to the economic analysis. But given the length and detail of the investment costs, it will be cumbersome to repeat the same sections once again only for the sole purpose of assigning a conversion factor to them. Instead, the three columns last columns of the investment cost tables are used to compute the conversion factors.

In the consequent financial and economic analysis, the expenditures on the equipment and machinery are consolidated into sections of the equipment costs, and a single conversion factor is

³ Approved qualifying foreign entities may qualify for the Foreign Investment Grant (FIG) up to a maximum of 3.0 million Rand. The grant is available only to new qualifying investments, and offered only once to any foreign

required for each section to estimate its total economic cost. Given the numerous equipment items, the analyst would generally like to keep all the investment costs data, and to compute a composite conversion factor for the equipment as whole as for the each section. This can be accomplished by taking a weighted average of the conversion factors of all items under a section through multiplying their shares in the total cost of equipment by the individual conversion factors. This can be formulated as:

$$CF_{SectionN} = \sum_{ItemM} (\%Share_{ItemM} * CF_{ItemM})$$

Note that the cost share of each item is based on the 2001 US-dollar values since it is the “original” data and it does not exclude any non-eligible grant expenses or local expenditures. For example, the cost share of the “blanking die and granular membrane” item (0.32%) in the “section of raw material, drying and storage” is calculated as its cost (4,395.24 US\$₂₀₀₁) over the total cost of the section (1,373,437.1 US\$₂₀₀₁).

The next column contains the conversion factor for each item. The conversion factors are taken from the *Electronic Database of Commodity Specific Economic Conversion Factors for South Africa (2003)*, which is referred as “Database” from nowon, and calculated using the methodology of as described in Chapter 6 of the *Manual (2003)*. The very last column has a description of the item in terms of the “harmonized standard code” and assumptions made about this item. Continuing with the example of the “blanking die and granular membrane” item, its description states that the South African Customs Authority would, most probably, treat all equipment items as being a whole machinery for an agricultural processing, which can be best described under one of the “harmonized code” items in Chapter 84.37 of the *Database (2003)*. The estimated CF for such machinery is estimated as 0.92544, and this is the value assigned to all equipment items of the section. However, the last three expenses on the electrical control, mounting and debugging cost, and other mounting material have their CFs calculated in the economic analysis, because these three items do not fit into the description of the equipment.

The very last row of every section has either a “total” or “grand-total”, which sums up all the computations done in each column. The conversion factor can be found there too. The CF for the “section of raw material, drying and storage” is found to be 0.91937. All the consequent sections follow the same format.

single entity. The FIG is the lower of the actual cost or 15% of the value of new machinery and equipment relocated from overseas. The FIG can not exceed 3.0 million Rand per project.

Note that “Electronic and Internet Control System” has several sections and because only a single conversion factor is required, then an additional computation is needed. Again, a composite CF is obtained by taking a weighted average of the cost share of each section and section’s conversion factor. At the very bottom of every section, an additional box is added with the computed share of this section in the total costs. For instance, the total cost of the “Weak Current Engineering and Internet Control System” is 118,804 US\$₂₀₀₁, which is exactly 40.32% of the 294,639 US\$₂₀₀₁ grand-total of the “Electronic and Internet Control System”. Since the composite CF for the “Section of Raw Material, Receive and Receiving Sieve” is estimated as 0.87810, then the product of this CF and section’s share in total costs will show the contribution of this section to the single CF for the “Electronic and Internet Control System”. Thus, placed below the computed share in feed production equipment costs, this contribution to the aggregate CF is computed as 0.35407. The aggregate CF for the “Electronic and Internet Control System” is found as 0.87512, which the sum of all sections’ contributions, as in Table II below.

Table II. Estimation of Economic Conversion factor for Feed Production Equipment.

Section	Share in Costs	* Composite CF =	Contribution
Weak Current Engineering and Internet Control System	40.32%	0.87810	0.35407
Electrical Machinery Control Centre (MCC)	37.01%	0.91624	0.33910
Work Field Material	22.67%	0.80270	0.18195
CF for Feed Production Equipment	(100.0%)		0.87512

The calculation of the aggregate CF for the all the other sections is performed in the same way as described above. Section 6.4 adds more insight into the estimation of the economic conversion factors.

5.4.6 Summary of Investment Costs

That summary of investment costs is made in Table 3H. This table is useful to bring together all the various investment costs into a single location. All the values appearing in this table are, in fact, references to the actual computations done above. The total investment costs can be broken into six categories: land, construction, equipment, freight and traveling, office equipment, and vehicles. The total investment costs, in real terms, amount to 88,652,055 Rand₂₀₀₂, which is the equivalent 7,578,679 US\$₂₀₀₂.

The next two columns of this table explicitly state the Rand and dollar cash requirements per each category of the investment costs, and their totals are computed below. Thus, Rand expenses will amount to 53,600,002 Rand₂₀₀₂ and US-dollar costs are expected to be 4,066,378 US\$₂₀₀₂. The reason why such a separation is needed is that it is useful to reflect the actual cashflows, and also for estimation of the loan requirements. Also, the owners of the plant will always need to know the currency requirements for better cash management.

Grant eligible expenses are also stated per each category of investment costs, and the total eligible amount is found as 86,574,444 Rand₂₀₀₂. However, the actual amount of grant is calculated as the minimum of either the total eligible costs, or 15% of the total eligible costs if the project's total investment costs exceed 3,000,000 Rand, or the maximum grant ceiling of 3,000,000 Rand. A function of MS-Excel, called "min" does such a comparison and in the case of this plant, the likely amount of the grant will be the maximum 3,000,000 Rand. This is also the amount which has been approved by the National Government as an incentive for this project. The regulation states that the grant must be given in two equal installments over two years, on the condition that the project does perform according to the approved application. If not, the second installment should not be given. It has been assumed that the feed production will be awarded both installments, and then, the actual grant inflow will be 1.5 million Rand in year 2002 and 2003.

At the very end of this table, there are three columns for tax depreciation of equipment and machinery, whose existence here is needed to estimate a deduction from the investment costs due to the government grant. The tax code of South Africa allows a tax deduction for the depreciation of the capital costs; however, the total deductible investment costs must be reduced by the grant amount, which is paid from the Government budget. Instead of consolidating all the investment costs into a single item and then reducing its value by the grant amount, it is possible to find the amount of grant per each eligible category of the investment costs, assuming that this grant "spread" would follow the investment cost structure. This allows the analyst to work out a consistent model with separate items under investment costs.

Thus, the Rand₂₀₀₂ equipment costs are taken into the first of these three columns, and their total is computed at the bottom. Then the shares of each kind of equipment are calculated. Once the shares are known, it is reasonable to assume that the base-value of each kind of equipment should be reduced in proportion to its share in the 3.0 million grant. The very last column states that amount per equipment kind, which is to be deducted from the base-value of equipment for estimation of tax depreciation.

The item which has only been left behind is the total energy requirement of the feed plant. This is simply a sum of all the energy requirements of the equipment and machinery. This monthly power design consumption works out to be 2,248.23 kWh, using a 100% plant load factor.

5.5 Loan Schedule

A typical project finds it worthwhile to use a mix of financing sources. In addition to the equity, the most common source of finance for start-up enterprises is a commercial loan from a bank. This is a competitive finance option and the project owners have flexibility over the choice of a particular bank and ability to negotiate and structure the deal. The financial model offers the unique capability to test the performance of the project under various financing packages, and to select the most “optimal” mix of funds. What is really extraordinary about financial modeling is that a properly constructed model allows the analyst to change the proportions of the funds from different sources, their interest rates and required rates of return, as well as the terms and conditions of the financing, and much more. Table 4 shows the Loan Schedule of the project.

The intention of the feed plant management was to obtain a local loan to cover some of the Rand expenses during the construction and starting phase. However, it has been stated that no plans are made about reliance on such external finance, and during the interviews with a company representative, a figure of about 50% of the local costs emerged as a preliminary estimate of external borrowing. In other words, all the US-dollar expenses and the other half of the local costs cash outlays that are to be financed by the equity contributions of the foreign investor.

It is relatively easy to obtain a loan of such amount on a commercial basis in South Africa, and a set of typical conditions for such a loan was assumed. The Table of Parameters describes the loan package in detail, and all the parameters used here can be referenced back to Section 5.2.3. The purpose of Table 4 is to project the loan inflows and outflows in a flexible manner, to incorporate all the loan parameters into the model. In other words, the Loan Schedule must automatically adjust for any change in the interest rate, duration of grace period, and number of annual installments. To model these desired properties into the financial model, a handful of formulas are used.

Loan Receipts: The first line of the schedule is the loan receipts, stating the amount of loan received in every year according to actual loan disbursements from the bank. All figures are expressed in nominal domestic currency to reflect the actual cash flows. If a loan is drawn in a

foreign currency then the loan schedule must be carried out in that currency, assuming that the repayment is also in the same foreign currency, and only nominal values should be used. The amount of the loan taken by the feed plant in year 2002 is 26.8 million Rand, which is the half of all the local investment and preliminary costs.

Annual Interest Rate: The annual interest rate line is needed to reflect the changing nature of the loan market, since any inflationary pressure is likely to increase the current nominal interest rates. This is modeled in such a way that it incorporates the current inflation rate into the interest rate computation. The function, linking the two can be expressed as:

$$i_{\text{YearX}} = r + R + (1 + r + R) * gP^e_{\text{YearX}}$$

$$i_{2003} = 8.5\% + 0\% + (1 + 8.5\% + 0\%) * 6.0\% = 15.0\%$$

Where the annual nominal interest rate (i_{YearX}) is based on the real interest rate (r) and country risk premium (R), which is in the case of a domestic loan is commonly taken as zero, and then adjusted for the expected rate of domestic inflation for the current year (gP^e_{YearX}). The real interest rate is assumed to remain at the same level of 8.5%, but this assumption can be relaxed later in the sensitivity and risk analysis. Note that the inflation rate already incorporates the unexpected “disturbances” and if any exogenous factor causes the inflation rate to increase or decrease, then the nominal interest rate will immediately change in the computed expected payment. The purpose of this line in the loan schedule is to show explicitly what will be the nominal borrowing rate in each year.

Repayment Installment: The next line of this table, named “repayment installment”, is used to calculate the repayment installment based on the accumulated “outstanding debt balance at the end of the year” and current nominal interest rate. There is a special function, called “PMT”, which is built-in in MS-Excel to calculate the payment for a loan, based on constant payments and a constant interest rate. Because the function returns a calculated payment as a negative number, a minus sign is required in front of the function in order to keep all flows with positive signs. The formula can be written as:

$$\text{RINST}_{\text{YearX}} = -\text{PMT}(i_{\text{YearX}}, n, \text{Debt}^B_{\text{YearX}})$$

For example, if the loan has to start repayment in year 2004 then the calculation of a fixed annual repayment with the nominal interest rate (i_{YearX}) of 15.0%, a repayment period (n) of 5 years, and an accumulated outstanding debt at the beginning of the 2004 year ($\text{Debt}^B_{\text{YearX}}$) of 30,822,681 Rand, would be:

$$RINST_{2004} = -PMT(15.0\%, 5 \text{ years}, 30,822,681 \text{ Rand}_{2004}) = 9,197,062 \text{ Rand}_{2004}$$

The value of the calculated repayment installment will be enough to compensate the bank for a loan of 30,822,681 Rand, if 5 equal annual repayments are made. However, the loan repayment does not start in this year, then a bigger amount of the accumulated debt ($Debt^B_{YearX}$) will have to be repaid back by the project, and that is why each year has a different amount of the calculated installment.

Outstanding Debt at the Beginning of Year: The outstanding debt at the beginning of the year shows the opening balance of the debt flow. It is assumed that the loan account is “opened” at the beginning of every year and “closed” at the end. Thus, the opening balance of the current year is always equal to the ending balance of the previous year ($Debt^B_{YearX} = Debt^E_{YearX-1}$) and the value of the opening balance always takes on the value of the end balance of the previous year. For example, the opening balance of year 2004 is the closing balance of year 2003. As a matter of fact, the opening balance of year 2002 is zero, i.e. the loan has not been received.

The interest accrued line is meant to show the amount of annual interest accrued on the debt balance during the current year. It is common for such loans to have a condition of “capitalization” of accrued interest to the loan principle. Because the loan funds are tied up with this project, the bank is in a position to charge the project for the use of capital and the relevant base for applying the accrued interest is not the original loan principal but the current debt balance, which should include all previous amounts of capitalized interest accrued. The formula, used to calculate the current year interest accrued is:

$$INT^A_{YearX} = i_{YearX} * Debt^B_{YearX}$$

$$INT^A_{2004} = 15.0\% * 30,822,681 \text{ Rand}_{2004} = 4,626,484 \text{ Rand}_{2004}$$

In other words, a debt balance of 30,822,681 Rand₂₀₀₄ will result in an amount of 4,626,484 Rand₂₀₀₄ in annual interest accrued, at the current interest rate of 15.0%. This does not mean that this amount is actually paid back to the bank, but it does imply that this amount is definitely included into the debt balance.

Annual Repayment Installment: The annual repayment installment line is needed to show the actual amount of installment paid to the bank in a year. Note that there are no installments made before and after the installment repayment period of 5 years, starting in 2004. The installment is a sum of two parts: the payment of the current year interest accrued and the

repayment of principal. The relative proportions of these two parts change over time, and that is why two additional rows are needed below: one is for the amount of interest to be paid and the second is for the amount of principal payment.

The spreadsheet form of the annual repayment installment formula is somewhat complex due to the various requirements constraining it. The constraints are such that the annual repayment installment must be zero in the years before and beyond the actual repayment period, and during the repayment period it should show the same amount of computed annual installment, taken from the calculated above annual installment of the year of the very first repayment. These requirements can be all served at the same time by using a MS-Excel “IF” function, modeled in the following manner:

$$\begin{aligned} \text{INST}_{\text{YearX}} = & \text{IF}(\text{Y}_{\text{YearX}} > \text{Y}_{\text{YearLast}}, 0, \\ & \text{IF}(\text{INST}_{\text{YearX-1}} > 0, \text{INST}_{\text{YearX-1}}, \\ & \text{IF}(\text{AND}(\text{Y}_{\text{YearX}} = \text{Y}_{\text{YearFirst}}, \text{INST}_{\text{YearX-1}} = 0), \text{RINST}_{\text{YearX}}, 0))) \end{aligned}$$

The first line checks the clause if the current year (Y_{YearX}) is beyond the last year of the loan repayment ($\text{Y}_{\text{YearLast}}$), and if this is true then the value of zero is set and the formula stops. If this is not true then the formula checks the previous year’s annual repayment installment ($\text{INST}_{\text{YearX-1}}$), and if it is greater than zero then the same value as the last year must be used, meaning that this year is inside the repayment period and a fixed installment is paid every year. The formula stops and no further action is taken. However, if the previous year’s annual repayment installment ($\text{INST}_{\text{YearX-1}}$) was, in fact, zero, zero then the formula continues with the next “IF” clause. The last line checks if two conditions are true at the same time: the current year (Y_{YearX}) is the first year of loan repayment ($\text{Y}_{\text{YearFirst}}$) and the previous year’s annual repayment installment ($\text{INST}_{\text{YearX-1}}$) was indeed zero. If both hold true, then the formula fetches the value of this year’s repayment installment ($\text{RINST}_{\text{YearX}}$) and shows its value in the formula. If neither of the conditions holds, then a value of zero is displayed. There are examples how this formula works in years 2003, 2004, 2006 and 2010:

$$\begin{aligned} \text{INST}_{2003} = 0 \text{ Rand} = & \text{IF}(2003 > 2008, 0, & \{\text{false, continue...}\} \\ & \text{IF}(0 > 0, 0, & \{\text{false, continue...}\} \\ & \text{IF}(\text{AND}(2003 = 2004, 0 = 0), 7,996,750 \text{ Rand}, 0))) & \{\text{false, stop.}\} \end{aligned}$$

$$\begin{aligned} \text{INST}_{2004} = 9,197,062 \text{ Rand} = & \text{IF}(2004 > 2008, 0, & \{\text{false, continue...}\} \\ & \text{IF}(0 > 0, 0, & \{\text{false, continue...}\} \\ & \text{IF}(\text{AND}(2004 = 2004, 0 = 0), 9,197,062 \text{ Rand}, 0))) & \{\text{true, stop.}\} \end{aligned}$$

$$\text{INST}_{2006} = 9,197,062 \text{ Rand} = \text{IF}(2006 > 2008, 0, \{ \text{false, continue...} \})$$

$$\text{IF}(9,197,062 \text{ Rand} > 0, 9,197,062 \text{ Rand}, \{ \text{true, stop.} \})$$

.....

$$\text{INST}_{2010} = 0 \text{ Rand} = \text{IF}(2010 > 2008, 0, \{ \text{true, stop.} \})$$

.....

Interest and Principal Repayments: Having computed the annual repayment installment ($\text{INST}_{\text{YearX}}$) for every year, it is useful to know the amounts of the interest repayment ($\text{INT}^{\text{P}}_{\text{YearX}}$) and principal repayment ($\text{PRI}^{\text{P}}_{\text{YearX}}$) in it. The reason for this inquiry is that the tax code of many countries, including South Africa, allows for a deduction of interest expenses from the company's tax liability. But the principal repayment is excluded and that is why such a separation is needed here. It is assumed that the amount of interest paid ($\text{INT}^{\text{P}}_{\text{YearX}}$) is equal to the interest accrued in that year ($\text{INT}^{\text{P}}_{\text{YearX}} = \text{INT}^{\text{A}}_{\text{YearX}}$), given that the actual annual repayment installment is paid ($\text{INST}_{\text{YearX}} > 0$). If the actual annual repayment installment is not paid in the current year, then both interest paid and principal paid ($\text{PRI}^{\text{P}}_{\text{YearX}}$) must be zero too. A simple "IF" function can be used to model such conditions:

$$\text{INT}^{\text{A}}_{\text{YearX}} = \text{IF}(\text{INST}_{\text{YearX}} > 0, \text{INT}^{\text{A}}_{\text{YearX}}, 0)$$

Then, figuring out the amount of the principal repayment ($\text{PRI}^{\text{P}}_{\text{YearX}}$), is an easy task, and can be done by subtracting the interest repayment from the annual repayment installment:

$$\text{PRI}^{\text{P}}_{\text{YearX}} = \text{INST}_{\text{YearX}} - \text{INT}^{\text{P}}_{\text{YearX}}$$

Notice the relationship between the principal repayment and interest repayment over time: as the share of interest repayment declines the share of principal repayment raises.

Outstanding Debt at the End of Year: The outstanding debt at the end of the year ($\text{Debt}^{\text{E}}_{\text{YearX}}$) is needed to calculate the net changes to the debt balance during the year. It is calculated as the amount of debt at the beginning of the year, plus any new loan proceeds, plus the interest accrued for the current year, and less any loan repayments. All this can be expressed as:

$$\text{Debt}^{\text{E}}_{\text{YearX}} = \text{Loan Receipts}_{\text{YearX}} + \text{Debt}^{\text{B}}_{\text{YearX}} + \text{INT}^{\text{A}}_{\text{YearX}} - \text{INST}_{\text{YearX}}$$

$$\text{Debt}^{\text{E}}_{2005} = 0 + 26,252,103 + 3,940,441 - 9,197,062 = 20,995,482 \text{ Rand}_{2005}$$

A few more lines at the end of this table are useful for the further analysis. The line with the annual interest payments (INT^A_{YearX}) simply refers to the corresponding amount in the table. This line will be used in the income tax statement later.

The last two lines with the nominal and real annual repayment installment ($INST^{Real}_{YearX}$) are typically needed for the estimation of the debt ratios later on. Because the real amount of annual repayment installment is needed there, the nominal installment repayment ($INST^{Nominal}_{YearX}$) must be deflated by the current domestic price index (I^D_{YearX}):

$$INST^{Real}_{YearX} = INST^N_{YearX} / I^D_{YearX}$$

$$INST^{Nominal}_{2005} = 9,197,062 \text{ Rand}_{2002} / 1.19 = 7,722,031 \text{ Rand}_{2005}$$

A cross-check of the loan cashflows can be easily made by calculating the present values (PVs) of the loan receipts and annual loan repayment installments, which include both the principal and interest repayments. By definition, the PV of the annual loan repayment installments ($INST^{Nominal}_{YearX}$) must be equal to the PV of the loan receipts ($LR^{Nominal}_{YearX}$), where both streams of repayments and receipts are discounted by the nominal interest rate. In other words, the loan repayment, including interest, must be equal to loan borrowed once it is adjusted for the time value of money. The formula for estimating the PVs is applied by using the “NPV” function of MS-Excel, which calculates the present value of a cashflow at a given discount rate:

$$PV_{\text{Loan Receipts}} = NPV(i, LR_{2003}:LR_{2013}) + LR_{2002}$$

and

$$PV_{\text{Loan Repayments}} = NPV(i, INST_{2003}:INST_{2013}) + INST_{2002}$$

Note that because year 2002 is the base year, all future expenditures and receipts should be discounted to year 2002 in order to account for the time value of money. However, the value for year 2002 does not need to be discounted; it should be excluded from the NPV formula and added to the resulting NPV as shown above. The formula starts with the receipts and repayments in year 2003, not year 2002, and includes values for all years till the end of the project life, year 2013. If both present values are equal, this means that the modeling of the loan schedule was carried out correctly.

A final note on the Loan Schedule would be a reminder that if several loans are involved, then each has to be modeled in the same way explained above. Foreign currency loans are modeled in the currency in which they are paid back to the bank. If all the modeling procedures are followed correctly, then the resulting loan schedule will feature an automatic adjustment to any change in

the loan parameters. This enhances the ability of the analyst to evaluate the different financing options for the project.

5.6 Schedule of Feed Ingredient Costs and Feed Prices

5.6.1 Feed Ingredient Costs

Table 5 contains the Schedule of Feed Ingredient Costs and Feed Prices. This table is needed to project into the future the nominal costs of the feed ingredients and nominal feed prices. The fluctuating nature of agricultural prices forces the analyst to apply a disturbance factor on the costs of feed ingredients in order to imitate their likely behavior over years. As stated in the Table of Parameters, the 950 Rand/ton cost of feed is made up of a few components: tradable (50%) and non-tradable (40%) ingredients, transportation cost (8%), and handling cost (2%). The reason, why it is necessary to look at the components separately, is that the different component are factors that affect each in a distinct way, hence, it is more realistic to model them separately.

Tradable Ingredients: The tradable ingredients are assumed to be affected by the foreign inflation because the international market will adjust to the US-dollar inflation. It is important to differentiate the real cost changes from the inflation adjustments. The value of tradable ingredients, in real US dollars, can be found as the real cost of feed ingredients, expressed in the 2002 prices, times the share of tradable ingredients, and again times the percentage change in the real cost of feed ingredients:

$$\begin{aligned}\text{Tradable Value (US\$}^{\text{Real}}_{2002}) &= \text{Cost}^{\text{Ingredients}}_{2002} * \% \text{ Tradable} * (1 + \% \Delta \text{Cost}^{\text{Ingredients}}_{2002}) / E_{\text{Adj}}^{\text{Nominal}}_{2002} \\ \text{Tradable Value (US\$}^{\text{Real}}_{2002}) &= 950 \text{ Rand/ton} * 50\% * (1 + 0\%) / 11.7 \text{ Rand/US\$} = 40.6 \text{ US\$}_{2002}/\text{ton}\end{aligned}$$

This formula is needed only for year 2002, and in the consequent years this real value of tradable ingredients will follow the foreign inflation rate, while its real price is assumed to remain constant. In most circumstances the US-dollar price of tradable inputs would be known directly. In this case, however, the initial costs of feed ingredients are known in the domestic Rand price. The nominal US-dollar value of tradable ingredients for any year can be estimated as:

$$\begin{aligned}\text{Tradable Value, US\$}^{\text{Nominal}}_{\text{YearX}} &= \text{Tradable Value, US\$}^{\text{Real}}_{2002} * I^{\text{F}}_{\text{YearX}} \\ \text{Tradable Value}^{\text{Nominal}}_{2004} &= 40.6 \text{ US\$}_{2002}/\text{ton} * 1.05 = 42.7 \text{ US\$}_{2004}/\text{ton}\end{aligned}$$

The resulting nominal US dollar price is a function of the foreign price index. In order to use this price in further analysis, a conversion has to be made from nominal dollar prices to the

nominal Rand prices. This can be achieved by multiplying the value of tradable ingredients by the adjusted nominal exchange rate of the current year:

$$\begin{aligned} \text{Tradable Value, Rand/ton}^{\text{Nominal}}_{\text{YearX}} &= \text{Tradable Value, US\$}^{\text{Nominal}}_{\text{YearX}} * E_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} \\ \text{Tradable Value}^{\text{Nominal}}_{2004} &= 42.7 \text{ US\$}_{2004}/\text{ton} * 12.51 \text{ Rand/US\$}_{2004} = 533.7 \text{ Rand}_{2004}/\text{ton} \end{aligned}$$

Non-Tradable Ingredients: The projection of non-tradable ingredients, transportation and handling costs is similar but they are all linked to the domestic rate of inflation, instead of foreign inflation. The real value of non-traded ingredients for year 2002 can be estimated as a product of the feed ingredient cost and the share of non-tradables in it, with a provision for the change in the real cost of feed ingredients:

$$\begin{aligned} \text{Non-tradable Value, Rand/ton}^{\text{Real}}_{2002} &= \text{Cost}^{\text{Ingredients}}_{2002} * \% \text{ Non-tradable} * (1 + \% \Delta \text{Cost}^{\text{Ingredients}}_{2002}) \\ \text{Non-tradable Value}^{\text{Real}}_{2002} &= 950 \text{ Rand}_{2002} / \text{ton} * 40\% * (1 + 0\%) = 380.0 \text{ Rand}_{2002}/\text{ton} \end{aligned}$$

The assumption is taken that the calculated real values remain constant over time, but it will be annually adjusted for the domestic inflation. Then, the nominal value of non-tradable ingredients in any year can be found as a product of its real, year 2002 value, and the current domestic price index:

$$\begin{aligned} \text{Non-tradable Value, Rand/ton}^{\text{Nominal}}_{\text{YearX}} &= \text{Rand/ton}^{\text{Nominal}}_{2002} * I^{\text{D}}_{\text{YearX}} \\ \text{Non-tradable Value}^{\text{Nominal}}_{2004} &= 380.0 \text{ Rand}_{2002}/\text{ton} * 1.12 = 427.0 \text{ Rand}_{2004}/\text{ton} \end{aligned}$$

The nominal cost projection for the transportation and handling costs are done in the same way as for the nontradables ingredients. The unadjusted average nominal cost of feed ingredients is the summation of the nominal projections of tradable, non-tradable ingredients, transportation, and handling costs, and is computed as:

$$\begin{aligned} C_{\text{Unadj}}^{\text{Nominal}}_{\text{YearX}} &= \text{Tradable Value}^{\text{Nominal}}_{\text{YearX}} + \text{Non-Tradable Value}^{\text{Nominal}}_{\text{YearX}} + \text{Transportation Cost}^{\text{Nominal}}_{\text{YearX}} + \text{Handling Cost}^{\text{Nominal}}_{\text{YearX}} \\ C_{\text{Unadj}}^{\text{Nominal}}_{2004} &= 533.7 + 427.0 + 85.4 + 21.3 = 1,067.4 \text{ Rand}_{2004}/\text{ton} \end{aligned}$$

Adjustment for Unforeseen Cost Changes: However, an adjustment is needed in order to model the unexpected annual fluctuations in the real price of the commodity, which originate outside the model. Again, a “disturbance” factor is used for this purpose. The risk analysis will deal with assignment of a probability distribution for this parameter, as will be discussed in Section 8.1.3. The adjusted average nominal cost of feed ingredients can be derived as:

$$\begin{aligned} C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} &= C_{\text{Unadj}}^{\text{Nominal}}_{\text{YearX}} * (1 + \text{Disturbance Factor to Cost of Ingredients}_{\text{YearX}}) \\ C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} &= 1,067.4 * (1 + 0\%) = 1,067.4 \text{ Rand}_{2004}/\text{ton} \end{aligned}$$

Thus, the adjusted nominal cost of feed ingredients incorporates the effect of both foreign and domestic price movement, as well as a provision for any other exogenous impacts. This adjusted cost projection can be readily used in the subsequent cashflows statements.

5.6.2 Feed Prices

This schedule is a part of Table 5 and it is required to project the feed prices into the future. Because there are several kinds of feed to be produced by the plant, a separate forecast is done for each type of feed. As already discussed in Section 5.2.20, the feed price is treated as a function of the cost of ingredients and the milling fee. This follows from the competitive nature of the industry. This relationship has a strong implication for the modeling of the feed prices since any change in the cost of ingredients, either expected or totally unexpected, must immediately impact on the feed prices. Such a relationship can be written as (given that the shares of the cost of ingredients and cost of milling add up to one, i.e. $\alpha_{\text{Ingredients}} + \alpha_{\text{Milling}} = 1$):

$$\begin{aligned} \text{Price of Feed} &= \text{Cost of Feed Ingredients} + \text{Milling Fee} \\ \% \Delta P_{\text{Feed}} &= (\% \Delta C_{\text{Ingredients}} * \alpha_{\text{Ingredients}}) + (\% \Delta \text{Fee}_{\text{Milling}} * \alpha_{\text{Milling}}) \end{aligned}$$

Despite that the break-even milling fee is a feed price determinant, the 0.12 share of milling costs is derived not from the milling fee share in the feed price but from the ratio of the PV of the cost of milling in the PV of the total costs in Table 64, and described in Sections 5.2.21 and 6.4.20.

The very first line of the Schedule of Feed Prices deals with the change in the cost of feed ingredients, while the second line shows the impact of the change in the milling fee, and the third line combines the two and shows the net effect of changes on the real feed price. Note that the changes in the feed price are changes to the real price, rather than to the nominal feed price.

Feed Price Adjustment due to Change in Cost of Ingredients: The price adjustment due to change in cost of ingredients is the impact of changing ingredients cost on the feed price, while keeping the change in the cost of milling constant. The computation of this adjustment can be done by constructing the following formula:

$$\text{Price Adjustment (C)}_{\text{YearX}}, \% \Delta = (\% \Delta C_{\text{Ingredients}} + \text{Disturbance to Cost of Ingredients}_{\text{YearX}}) * \alpha_{\text{Ingredients}}$$

The change in cost of ingredients ($\% \Delta C_{\text{Ingredients}}$) and share of the feed ingredients ($\alpha_{\text{Ingredients}}$) are explicit variables built into the Table of Parameters, and the annual disturbance to the cost of feed ingredients is taken from the Schedule of Feed Ingredients Costs. In other words, any expected or unexpected changes in the cost of ingredients will affect the feed price only to the

degree of the ingredients' share in the feed, which is calculated as 0.88. Let's assume that in a particular year X, the percentage change in the real cost of ingredients is set as 10%, but the actual disturbance factor in that year X for the ingredients is –5%, then the resulting price adjustment for feed would be:

$$\text{Feed Price Adjustment } (C_{\text{Ingredients}})_{\text{YearX}}, \% \Delta = (10\% + [-5\%]) * 0.88 = 4.4\%$$

This is an understandable outcome, meaning that since the net impact of the cost changes plus 5%, and then only 88% of this rise is translated into the feed price change, which is 4.4%.

Feed Price Adjustment due to Change in Milling Fee: Similarly, any change in the milling fee is translatable into the feed price change only to the degree of the milling cost share in the feed price, which is 0.12 as stated in Table of Parameters. It is assumed that the feed price estimated in this schedule will adjust with a change in the milling fee, even if the charges for milling by other feed producers do not change. But later, in Section 5.7, this price adjustment will be replaced by the quantitative adjustment of plant's production. There, the demand model will assume the plant as being a price-taker and the only tool to achieve market equilibrium for the plant will be to alter its production plans.

The milling fee is not a subject to unexpected annual fluctuation unlike the feed ingredients market prices, and, therefore, no need exists for introducing a disturbance factor. The formulation of this price adjustment can be presented as:

$$\text{Feed Price Adjustment } (\text{Fee}_{\text{Milling}}), \% \Delta = \% \Delta \text{Fee}_{\text{Milling}} * \alpha_{\text{Milling}}$$

The percentage change in the milling fee and the share of milling costs in feed are parameters defined in the Table of Parameters and they do not vary over time, i.e. the share of milling costs is assumed to remain constant and the same change in the cost of milling is applied to all years' milling fee. Let's take a hypothetical situation when the percentage change in the milling fee is 10%, which means that the amount charged to cover processing costs has been raised by 10%. Then, the following price adjustment will take place:

$$\text{Feed Price Adjustment } (\text{Fee}_{\text{Milling}}), \% \Delta = 10\% * 0.12 = 1.2\%$$

The percentage increase in the feed price will be only 1.2%, because relatively small share of the overall costs of producing feed is affected by this 10% rise in the milling fee.

Net Price Adjustment: The net price adjustment, as already stated above, is a sum of the two separated price effects. Continuing with the previous examples, let's estimate the net real price

adjustment in year X, where $\% \Delta C_{\text{Ingredients}}$ is 10%; disturbance factor in that year X is -5% ; and $\% \Delta \text{Fee}_{\text{Milling}}$ is taken as 10%:

$$\begin{aligned} \% \Delta P_{\text{Feed, YearX}} &= (\% \Delta C_{\text{Ingredients}} * \alpha_{\text{Ingredients}}) + (\% \Delta \text{Fee}_{\text{Milling}} * \alpha_{\text{Milling}}) \\ \% \Delta P_{\text{Feed, YearX}} &= (10\% + [-5\%]) * 0.88 + 10\% * 0.12 = 6.6\% \end{aligned}$$

This result came by as a product of the interaction of the annual change in the real ingredients costs and change in milling cost. All the consequent real feed price forecasts use this annual real net price adjustment to account for their annual fluctuations.

Feed Prices Forecast: There are forecasts for six types of feed, and all of them are done in the same manner. Taking the beef feed forecast as an example, the projection is done for both the real and nominal price of this feed. The reason for showing the real price explicitly is that it is important to capture the movement of the real prices, and while the annual changes in the real price are assumed to be zero here but the analyst can now easily model a change in the real price.

Thus, the real price of beef feed is simply referred to the corresponding figure in the Table of Parameters, and no change of this price, is expected over the project life. However, the nominal price will be annually adjusted for the domestic inflation in order to be consistent with the general price level. The formula used to inflate the real beef feed price also incorporates the calculated net price adjustment, and has a form of:

$$P_{\text{FeedN, YearX}}^{\text{Nominal}} = P_{\text{FeedN, YearX}}^{\text{Real}} * (1 + \% \Delta P_{\text{Feed, YearX}}) * I_{\text{YearX}}^D$$

Assuming that there is no change, either expected or unexpected, in the cost of feed ingredients and in the milling fee, the forecast of nominal beef feed price for year 2004 is calculated as:

$$P_{\text{Beef, 2004}}^{\text{Nominal}} = 1,333 \text{ Rand}_{2002}/\text{ton} * (1 + 0\%) * 1.12 = 1,498 \text{ Rand}_{2004}/\text{ton}$$

The forecasts for the other types of feed are done in exactly same way, based on their respective real prices from the Table of Parameters, discussed in Section 5.2.20. Their common average price in every year is worked out at the bottom of this table, as a weighted average of the nominal prices and shares of different kinds of feed in the total production:

$$P_{\text{W, YearX}}^{\text{Feed}} = \sum_{\text{FeedN}} (\text{Production}\%_{\text{FeedN, YearX}} * P_{\text{FeedN, YearX}}^{\text{Nominal}})$$

This nominal average price will be used in the valuation of the feed inventory, while individual prices of the different types of feed will enter the calculation of annual feed sales.

5.7 Capacity Utilization Schedule

This schedule deals with the projections of the plant capacity utilization factor, which describes the utilization of the plant's capacity in any year. Table 6 shows the Capacity Utilization Schedule. In any particular year, the plant's installed annual capacity of 360,000 metric tons may or may not be reached in full due to a number of reasons: market conditions for feed, feed marketing effort, availability and cost of raw materials, technical factors, etc. The financial model looks at the actual capacity utilization as an outcome of several forces: management's effort in the promotion of the feed sales and the market's demand and supply of feed. Because there are a number of other feed manufacturers in the Province, there is a constant competition pressure in this market.

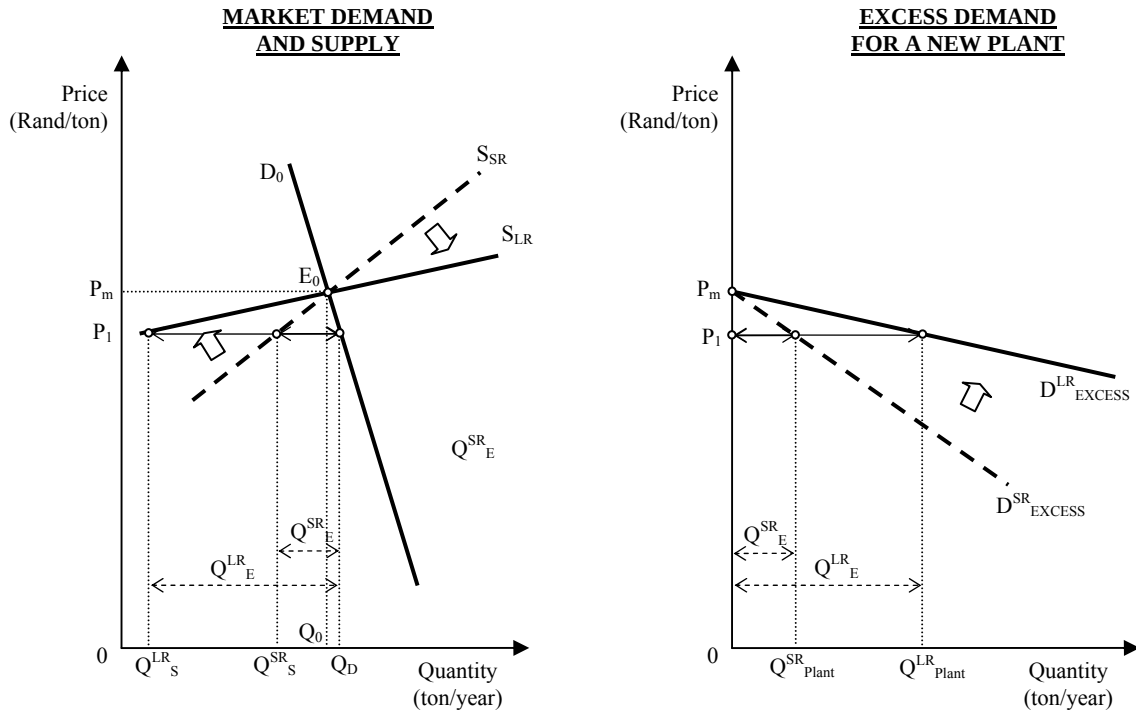
The capacity utilization factor combines the planned utilization of the plant with the current market conditions, which impact on the sales of feed by this plant as well as by the other producers. What is meant by the "current market conditions" is the frequent fluctuation in cost of feed ingredients, which are the main input into feed production at any plant. Also, if this feed plant has an ability to lower its overall milling costs, this should enable it to lower its feed prices and capture a larger market share, keeping all other factors constant.

This situation is best described by the "excess demand" facing the new plant. While there is equilibrium at the feed market right now, there is a range of prices at which the consumers will be willing to purchase additional quantity of feed. Figure III illustrates this concept. At the present equilibrium point E_0 the consumers of feed purchase Q_0 tons of feed a year at price P_m , and the manufacturers produce the required amount Q_0 tons/year. However, some of the consumers will purchase more feed if its price were lower than P_m , but the existing producers would supply less feed at such lower prices. Then, at any price below P_m there is a difference between the quantity demanded (Q_D) and quantity supplied (Q_S) by the existing producers. The difference is nothing else than the quantity of excess demand ($Q_E = Q_D - Q_S$) for any new producer who is able to operate at a lower price range.

It is not surprising that the excess demand curve is more elastic than the original total demand curve, because consumers would buy more and more feed at a successive lower price. In other words, the new producer faces an excess demand for feed that is substantially more elastic than the original market demand. The typical strategy by the industry entrants is to artificially lower their price below the price of the existing producers in order to attract customers. This is done by lowering the milling fee they charge as the ingredient costs are the same for everyone. Over time,

the competitive forces will determine who will survive among the existing and new producers, and once the new entrant firmly establishes on the market, his price is likely to return to his long-run equilibrium level.

Figure III. Short- and Long-Run Excess Feed Demand from a New Plant.



Once a new plant enters the industry with a lower price P_m , it faces an excess demand D^{SR}_{Excess} with quantity demanded from the plant at price P_m equal to Q^{SR}_{Plant} . If the new price level P_m is sustained for a sufficiently long period, then some of the inefficient producers will have to shut sown and leave the industry. In other words, the quantity of excess demand at P_m in the long-run is greater than in the short-run, and the new plant will face an excess demand D^{LR}_{Excess} with quantity demanded equal to Q^{LR}_{Plant} . Note that the long-run excess demand curve is more elastic than the short-run curve due to the fact that the consumers will definitely prefer the feed producer with a lower price.

The quantity of the feed demanded and sold by this plant can be characterized as a function of its cost of inputs and the size of the milling fee. Under the assumption of fixed market feed price, any change in the cost of ingredients or change in the cost of milling will affect the quantity of feed produced and sold by the project:

$$Q^{Plant} = f(C_{Ingredients}, C_{Milling})$$

In the analysis that follows, it is assumed that the changes in the total market that are caused by the feed price movements due to changes in the cost of ingredients and changes in the cost of milling happen only to the quantity of feed produced and sold by the plant, but not to the feed price. In other words, the plant is assumed to be a price-taker, and the only tool to regulate the optimal production in the short-run is the adjustment of its capacity utilization, i.e. quantity of feed produced and marketed. Under this assumption of constant feed price, any changes in the cost of feed production will directly impact on the quantity of feed manufactured by the plant. If the quantity-price relationship expanded within the variables of this model, then a percentage change in the quantity produced by this plant ($\% \Delta Q^{\text{Plant}}$) can be approximated by a sum of the changes in its cost of feed ingredients and the milling fee:

$$\% \Delta Q^{\text{Plant}} = [\eta_{\text{Feed}} * \alpha_{\text{Ingredients}} * \% \Delta C_{\text{Ingredients}}] + [\eta^{\text{Plant}}_{\text{Milling}} * \alpha_{\text{Milling}} * \% \Delta \text{Fee}_{\text{Milling}}]$$

Because, any price changes will alter the quantity of feed demanded, a detailed break-down of the functional relationship is needed. The two exogenous variables in this formula are the percentage change in the feed ingredients cost ($\% \Delta C_{\text{Ingredients}}$) and the percentage change in the milling fee ($\% \Delta \text{Fee}_{\text{Milling}}$), assuming that the cost of ingredients and milling fees of other producers remain constant. All the other parameters are either assumed or determined within the model. The shares of feed ingredients ($\alpha_{\text{Ingredients}}$) and cost of milling (α_{Milling}) were specified in the Table of Parameters. Only the demand elasticity of feed (η_{Feed}) with respect to the price of feed and elasticity of demand for feed from the plant with respect to the change in the cost of milling ($\eta^{\text{Plant}}_{\text{Milling}}$) have to be estimated.

The above relationship between the quantity demanded and its price implies, is that the change in the quantity demanded facing the plant is both affected by the changes in the plant's demand for feed caused by changes in the cost of ingredients, which affect all manufacturers, as well as changes in the plant's milling fee, relative to the milling fees charged by other producers. What is interesting here is that the price fluctuations of the feed ingredients have an effect on all feed producers since they all purchase the same raw materials, but adjustments of demand due to the changes in the milling fee shifts only the plant's demand, without affecting other producers.

The value of own-price elasticity of demand for feed can be found from its relationship with the own-price elasticity of demand for meat. It is actually a derived demand from the demand for meat, where the own-price demand elasticity of demand for feed is the product of the feed share in meat production times the own-price elasticity of demand for meat:

$$\eta_{\text{Feed}} = \alpha_{\text{Feed}} * \eta_{\text{Meat}}$$

$$-0.6 = 0.6 * (-1.0)$$

The share of feed in meat production (α_{Feed}) and demand elasticity of meat (η_{Meat}) are taken from outside sources, whose origin was already described in the Table of Parameters.

Feed Production in Province: The last variable missing in the formula is the demand elasticity for feed facing the plant that arises from a change only in its own milling fee ($\eta^{\text{Plant}}_{\text{Milling}}$). The elasticity of demand facing the plant is a measure of the market response to the plant when it alters its milling fee. Why this variable deserves attention here is because the overall costs of milling and long-run break-even milling fee describe the efficiency of the plant as compared to other producers, and if this plant possesses any economies of scale in production of feed, this will be expressed in a lower milling fee needed to break-even, as compared to other producers.

The elasticity of demand for plant's milling is the elasticity of excess demand facing the plant and it can be expressed in terms of the feed's overall price elasticity of demand, the plant's share in the total provincial feed production ($Q^{\text{T}}/Q^{\text{Plant}}$), and supply elasticity of other feed producers ($\epsilon^{\text{Others}}_{\text{Milling}}$):

$$\eta^{\text{Plant}}_{\text{Milling, YearX}} = \eta_{\text{Feed}} * (Q^{\text{T}}_{\text{YearX}}/Q^{\text{Plant}}_{\text{YearX}}) - \epsilon^{\text{Others}}_{\text{Milling}} * (Q^{\text{Others}}_{\text{YearX}}/Q^{\text{Plant}}_{\text{YearX}})$$

The projections of the quantities produced and sold by the plant and other manufacturers are made in Table 6, but the elasticity of supply for milling by other manufacturers is a parameter, not readily observable. As it was already mentioned in Section 5.2.21, the supply elasticity of the feed production in the Province is indeed elastic and a reasonable assumption of 5.0 is made. Later, sensitivity tests will help to evaluate the full impact of this parameter on the model.

Thus, the only outstanding variables not specified at this point are the annual quantity of production by other manufacturers and annual quantity of the total provincial production. The production by other manufacturers can be found by subtracting plant's production from the total provincial feed sales. A future forecast of quantities produced for all years is necessary.

The planned plant production is based on the proposed “planned” capacity utilization in the Table of Parameters, which can be easily achieved technically but require a sufficient marketing effort. It is assumed that all the planned production can be sold on the market. The total provincial feed production is an estimate of the feed consumed in the Province. This estimate is based on the figure of 400,000 tons of feed consumption in the Province in year 2000. Because the feed project's starting point is year 2002, this provincial estimate has to be adjusted to its year 2002

level and further into the future. Since a 3.0% annual growth rate was taken as an estimate of the provincial long-run trend in the demand for feed, then the projection of the total production and consumption follows this rate, starting from year 2002. The estimate of the total provincial demand in year 2003 would be:

$$Q^T_{\text{YearX, tons/year}} = Q^T_{\text{YearX-1}} * (1 + \text{Growth Rate})$$

$$Q^T_{2003} = 400,240 * (1 + 3.0\%) = 400,360 \text{ tons/year}$$

Production Estimate by Other Manufacturers: The feed production by other manufacturers is simply the difference between total provincial demand and this planned supply by the plant, assuming that the plant is able to market all of its planned production. This arrangement implies that these feed producers who have relatively high milling costs will have to either cut their fees, or to go out the business. Of course, it is unrealistic to foresee the exact impact on the other producers. Now, it is possible to figure out the production by others, by subtracting the planned production by the plant from the total provincial feed sales:

$$Q^{\text{Others}}_{\text{YearX, tons/year}} = Q^T_{\text{YearX}} - Q^{\text{Plant}}_{\text{YearX}}$$

$$Q^{\text{Others}}_{2003, \text{ tons/year}} = 400,360 - 180,000 = 220,360 \text{ tons/year}$$

Elasticity of Demand for Feed with Respect to Plant Milling: Returning back to the estimation of the elasticity of demand for feed with respect to the plant's changes in the cost of milling, it is now easy to fill the missing parameters in the formula with the computed values:

$$\eta^{\text{Plant}}_{\text{Milling, 2003}} = (-0.6) * (400,360 / 180,000) - 5.0 * (220,360 / 180,000) = -7.5$$

Over years, this elasticity of demand facing the plant is declining due to the fact that the market share of the plant, relative to other producers, is increasing. In other words, while the plant is operating at low capacity levels, the responsiveness of the buyers of feed to any change in the milling cost of any plant is very high.

Change in Cost of Ingredients and Change in Milling Fee: These two lines are useful here to show explicitly what the annual changes in both variables might be. Note, while the change in the milling fee refers directly to the Table of Parameters, the change in cost of ingredients is a sum of the expected cost adjustment, which is taken from Table of Parameters, and its unexpected annual disturbance, taken from the Schedule of Feed Ingredients Costs and Feed Prices. Thus, the annual change in cost of ingredients combines two cost effects.

Change in Demand due to Change in Cost of Ingredients: It is assumed that the plant will maintain its share in the total supply in the provincial feed market. Since the plant has been assumed being a price-taker, any change in the cost of feed ingredients will translate into an

adjustment of the plant's supply. A different quantity of feed would be supplied by the plant at each point in the cost range of the inputs, assuming the feed price is kept constant. Having estimated all the required parameters for modeling the percentage change of the feed production enables the analyst to proceed with combining the different parts into a single formula. Again, it is easier and more transparent to show the two effects separately.

Thus, there are two lines, one for the change in planned production due to changes in price due to changes in the cost of ingredients, and the second for change in planned production due to changes in the demand facing the plant due to changes in its milling fee. It is assumed that the plant will adjust its production to match the demand for its feed as long as this demand does not exceed the technical capacity of the plant.

The annual change in the planned production due to a change in the cost of feed ingredients ($\% \Delta Q(C_{\text{Ingredients}})$) uses "IF" function of MS-Excel to filter out years when no operation takes place. The form of the function is:

$$\% \Delta Q(C_{\text{Ingredients}})_{\text{YearX}} = \text{IF}(Q^{\text{Plant}}_{\text{YearX}} = 0, , \alpha_{\text{Feed}} * \eta_{\text{Meat}} * \alpha_{\text{Ingredients}} * \% \Delta C_{\text{Ingredients}}, \text{YearX})$$

Note that the percentage change in the cost of feed ingredients ($\% \Delta C_{\text{Ingredients}}$) is taken as a sum of the annual disturbance factor and the cost change parameter. This assures that both expected and unexpected ingredients price fluctuations are modeled into the formula.

Change in Demand due to Change in Milling Fee: In a similar manner, the percentage change in the demand due to a change in the milling fee ($\% \Delta Q(\text{Fee}_{\text{Milling}})$) is computed on the annual basis:

$$\% \Delta Q(C_{\text{Milling}})_{\text{YearX}} = \eta^{\text{Plant}}_{\text{Milling, YearX}} * \alpha_{\text{Milling}} * \% \Delta \text{Fee}_{\text{Milling}}$$

Note that the annual component of this formula comes from the elasticity of the demand facing the plant with respect to its milling fee ($\eta^{\text{Plant}}_{\text{Milling}}$). The other two parameters are constant over the life of the project, and they are taken directly from the Table of Parameters.

Net Change in Demand: The net percentage change is a summation of the two formulas, representing the combined effect on the demand due to the changes in the cost of ingredients and milling fee:

$$\% \Delta Q^{\text{Plant}}_{\text{YearX}} = \% \Delta Q(C_{\text{Milling}})_{\text{YearX}} + \% \Delta Q(\text{Fee}_{\text{Milling}})_{\text{YearX}}$$

Adjustment of Planned Capacity Utilization: The calculated percentage change in the production is applied to the planned production. In order to model such a transition, an additional

line is used, named the “adjustment of planned capacity utilization”, which simply shows the deviation of the planned capacity utilization from its expected path, or:

$$\text{Adjustment of Planned Capacity Utilization}_{\text{YearX}} (\%) = 1 + \% \Delta Q^{\text{Plant}}_{\text{YearX}}$$

Actual Capacity Utilization: The adjustment factor really shows what is the shift in the planned production due to the changes in quantity demanded due to changes in price, caused by changes in the cost of ingredients and/or cost of milling. But another step is required to incorporate this factor into the actual production schedule. The planned capacity utilization factor must be multiplied by the computed adjustment in order to arrive at the “actual capacity utilization factor”:

$$\begin{array}{ccccc} \text{Actual Capacity} & & \text{Planned Capacity} & & \text{Adjustment of} \\ \text{Utilization} & = & \text{Utilization} & * & \text{Planned Capacity} \\ \text{Factor}_{\text{YearX}} (\%) & & \text{Factor}_{\text{YearX}} (\%) & & \text{Utilization}_{\text{YearX}} (\%) \end{array}$$

Let’s demonstrate how this mechanism will work on the example of year 2004, assuming that the expected percentage change in the cost of feed ingredients is 8.0%, while its unexpected rise (disturbance factor) is 2.0%, the percentage change in the milling fee is –3.0%, and the planned capacity utilization factor is 70.0%, which would result in planned production of 252,000 tons/year. The total consumption of feed in the Province is estimated to be of 400,360 tons. Thus, the following system of equations would be set in motion:

$$\% \Delta C_{\text{Ingredients}, 2004} = 8.0\% + 2.0\% = 10.0\%$$

$$\eta_{\text{Feed}} = 0.6 * (-1.0) = -0.6$$

$$\% \Delta Q(C_{\text{Ingredients}})_{2004} = (-0.6) * 0.88 * 10.0\% = -5.28\%$$

and

$$Q^{\text{Others}}_{2004, \text{ tons/year}} = 400,480 - 252,000 = 148,480 \text{ tons/year}$$

$$\eta^{\text{Plant}}_{\text{Milling}, 2004} = (-0.6) * (400,480 / 252,000) - 5.0 * (148,480 / 252,000) = -3.90$$

$$\% \Delta Q(C_{\text{Milling}})_{2004} = -3.90 * 0.12 * (-3.0\%) = 1.40\%$$

then

$$\% \Delta Q^{\text{Plant}}_{2004} = -5.28\% + 1.40\% = -3.88\%$$

then

$$\text{Adjustment of Planned Capacity Utilization}_{2004} (\%) = 1 + (-3.88\%) = 96.12\%$$

$$\text{Actual Capacity Utilization Factor}_{2004} (\%) = 70.0\% * 96.12\% = 67.29\%$$

$$\text{Actual Production}_{2004} = 360,000 * 67.29\% = 242,232 \text{ tons/year}$$

The actual capacity utilization factor can be readily used for further calculation of the production quantities, sales, inventory, and production costs. All the relevant demand and supply-side effects are already incorporated into the model.

The very last item of this table is a forecast of the production shares for the different kinds of feed. Because it was assumed that their relative proportions will remain constant, the annual values refer directly to the Table of Parameters.

5.8 Inventory Schedule

Since the business of this kind depends on the availability of raw materials, as well as its ability to meet customers demand, an inventory of feed ingredients and feed are held on the plant site. Because the amounts of inventory held are substantial, and it is expected that some minimum inventory level will be maintained at all times, the project analyst must account for the capital tied up with the inventory stocks. A useful way to look at such stocks is to remember that, although they are needed for smooth operation of the business, but still the capital held in inventories always has alternative uses and, therefore, has an opportunity cost. Table 7 presents the Inventory Schedules.

There are two inventory stocks that a feed producer maintains. The input inventory typically contains various feed ingredients used in the production and it is a precautionary stock, kept to safeguard the producers from frequent fluctuations in the prices of agricultural commodities. The second stock is the inventory of manufactured feed, kept to ensure a continuous availability of the product for the customers.

The two inventories differ in the way they built into the financial model. The plant's management needs to know the quantity of both the input and output inventory stocks, and that is the reason for constructing an explicit schedule of the feed ingredients and manufactured feed inventory stocks. The ultimate use of the Feed Ingredients Schedule in the further analysis will be estimation of the amount of purchased inventory in a year, which includes the ingredients for the current production as well as the precautionary inventory stock. This amount of purchased inventory is really the cost of inputs. It is assumed that any ingredients purchase is initially passing through the inventory and only then channeled either into the production or kept as part of the stock for the future use. The cost of purchasing the ingredients in a year will be used in the Income Tax Statement and in the cashflow statements as the cost of feed ingredients.

In regard to the Feed Inventory Schedule, it should firstly be noted that there is often a discrepancy between the quantity of feed produced during a year and quantity actually sold. The difference is the net change in the stock of manufactured feed, not sold out to the customers for whatever reason. In other words, the quantity of feed manufactured can be either sold or kept in the inventory for the future. The cashflow statements should, therefore, include the sales of feed, which are based on the quantity of feed actually sold, and should also include the change in the inventory of manufactured feed, which represents the net addition to the inventory stock during a year. The Feed Inventory Schedule calculates the quantity of feed sales and the net change in the feed inventory stock held on hand.

5.8.1 Feed Ingredients Inventory

The feed ingredients inventory is a good illustrative example of modeling the inventory flows into the financial analysis. The starting point of inventory schedule is to forecast the quantities held in stock at the beginning and end of the year, and any additions and withdrawals from the stock during a year. Only after the quantities of feed are calculated, their monetary valuation should be done.

Opening Inventory: This is the stock of feed ingredients at the beginning of the year, and it is assumed that this stock is the same at the end of the previous year, held in closing inventory. Obviously, there is no inventory on hand at the beginning of year 2002, but there should be some amount of feed ingredients already in stock by the end of this year, to ensure a smooth production flow. Since the last operating year is 2012, then the plant will not need any raw materials for year 2013, and the opening inventory will be zero in 2013. For example, year-2003 opening inventory takes the quantity of 16,500 tons from the closing inventory of year 2002.

Closing Inventory: The quantity of the closing inventory is determined by the production requirement for the next year. Referring back to the Table of Parameters, feed ingredients inventory requirements are stated for each year. This inventory of raw materials is set at 1 month in year 2002, when the plant is still being launched, but starting from year 2003, this input stock is kept for 2 months. The reason for storing such a large amount of feed ingredients is because of the large price fluctuations in the ingredients prices, and the desire to ensure a constant availability of the ingredients at the site. Thus, a typical quantitative estimation of feed ingredients inventory stock at the end of the year becomes formulated as:

$$\text{Closing Inventory}_{\text{YearX}} \text{ (tons/year)} = \text{Design Annual Feed Ingredients Requirement (tons/year)} * \text{Actual Capacity Utilization Factor}_{\text{YearX+1}} * \left(\frac{\text{Inventory}_{\text{YearX}} \text{ (months)}}{12 \text{ (months)}} \right)$$

$$\text{Closing Inventory}_{2003} = 396,000 * 70.0\% * (2 / 12) = 46,200 \text{ tons/year}$$

This formulation implies that regardless of how much was the opening stock, additions and consumption, the closing stock of feed ingredients must be a 2-month amount of the next year production. The reason why the closing balance is based on the next year production, instead of the current year production, is that the feed ingredients stock is kept for precaution reasons, and is typically estimated while looking into the future production plans. Since this model already has separated the planned production from actual production, it is now possible to step in with an assumption that the computed actual production can serve the basis for inventory estimation.

Consumed Inventory: This is the quantity of inventory actually gone into production, and it is simply the product of the design annual feed ingredients requirement from the Table of Parameters and the actual capacity utilization factor in that year, but not the next year:

$$\text{Consumed Inventory}_{\text{YearX}} \text{ (tons/year)} = \text{Design Annual Feed Ingredients Requirement (tons/year)} * \text{Actual Capacity Utilization Factor}_{\text{YearX}} \text{ (\%)}$$

$$\text{Consumed Inventory}_{2003} = 396,000 * 50.0\% = 198,000 \text{ tons/year}$$

Purchased Inventory: Because it is assumed that at the end of each year a certain quantity of feed ingredients should be always kept in stock, purchases are needed in order to maintain the desired level of inventories. Formulation of such purchases reveals that they are dependent on all the three above inventory items. Purchases in a given year can be figured out as:

$$\text{Purchased Inventory}_{\text{YearX}} = \text{Consumed Inventory}_{\text{YearX}} + \text{Closing Inventory}_{\text{YearX}} - \text{Opening Inventory}_{\text{YearX}}$$

$$\text{Purchased Inventory}_{2003} = 198,000 + 46,200 - 16,500 = 227,700 \text{ tons/year}$$

The valuation of the inventory stocks is the next step in modeling the inventory schedule. It is assumed that the valuation of the feed ingredients inventory is carried on a first-in-first-out (FIFO) basis. This means that the price of the oldest inventories (first in) is the value which is used to determine the cost of the goods sold later in the Income Tax Statement.

Value of Opening Inventory: Since the opening stock of inventory is taken from the end of the previous year, then the value of the opening inventory is calculated based on the adjusted nominal cost of feed ingredients in the previous year:

$$\begin{aligned}\text{Value of Opening Inventory, Rand}_{\text{YearX}} &= \text{Opening Inventory}_{\text{YearX}} (\text{tons}) * C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX-1}} (\text{Rand/ton}) \\ \text{Value of Opening Inventory}_{2003} &= 16,500 * 950 = 15,675,000 \text{ Rand}_{2003}\end{aligned}$$

Value of Closing Inventory: Because all the inventory units are measured at the end of the year, the relevant price for valuation of this stock is the current year price of the feed ingredients. This means that the closing value is a product of the closing stock times the current adjusted nominal cost of feed ingredients:

$$\begin{aligned}\text{Value of Closing Inventory, Rand}_{\text{YearX}} &= \text{Closing Inventory}_{\text{YearX}} (\text{tons}) * C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} (\text{Rand/ton}) \\ \text{Value of Closing Inventory}_{2003} &= 46,200 * 1,007 = 46,523,400 \text{ Rand}_{2003}\end{aligned}$$

Value of Purchased Inventory: This value is easy to measure because it is based on the actual expenses on the feed ingredients during a year. Therefore, it is calculated as the amount of consumed inputs multiplied by the current adjusted nominal cost of feed ingredients:

$$\begin{aligned}\text{Value of Purchased Inventory, Rand}_{\text{YearX}} &= \text{Purchased Inventory}_{\text{YearX}} (\text{tons}) * C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} (\text{Rand/ton}) \\ \text{Value of Purchased Inventory}_{2003} &= 227,700 * 1,007 = 229,293,900 \text{ Rand}_{2003}\end{aligned}$$

Value of Consumed Inventory: The value of consumed inventory is somewhat tricky to figure out, unless a firm assumption is made about the “composition” of the consumed amount. The issue here is that there is always some amount of raw materials in the inventory, and because the units purchased in the previous years are identical to the units purchased this year with no physical tracking usually done, the valuation of the consumed inventory should include both past and current year purchases. In order to simplify this accounting, an assumption is made that all stocks left from the previous year are consumed first, and then the current purchases fill in the remaining gap. In other words, the quantity of the opening inventory is valued at the previous year prices, then the difference between the consumed and opening inventory is valued at the current prices:

$$\begin{aligned}\text{Value of Consumed Inventory (Rand}_{\text{YearX}}) &= \text{Value of Opening Inventory (Rand}_{\text{YearX}}) + \left(\text{Consumed Inventory}_{\text{YearX}} (\text{tons}) - \text{Opening Inventory}_{\text{YearX}} (\text{tons}) \right) * C_{\text{Adj}}^{\text{Nominal}}_{\text{YearX}} (\text{Rand/ton})\end{aligned}$$

$$\text{Value of Consumed Inventory}_{2003} = 15,675,000 + (198,000 - 16,500) * 1,007 = 198,445,500 \text{ Rand}_{2003}$$

The intermediate use of the constructed feed ingredients inventory is twofold: the value of consumed inventory is an item of the income tax statement, while the value of purchased inventory is included into the operating costs of the cash flow statements. Apart from that, it is always useful to have future forecasts of the inventory stocks ready for the management use.

5.8.2 Feed Inventory

The feed inventory schedule is needed because a certain amount of manufactured feed will always be kept on hand in case of unexpected customer requests. It is safer for the business to have a little stock of the finished goods, rather than have an awkward situation when the firm is unable to serve a customer request. However, keeping such stocks is costly and, therefore, a reasonable balance should be achieved between these two constraints. From the experience of other feed manufacturers, it is not usual to keep 2-4 weeks of feed on-hand to assure the availability of the product for customers. As already mentioned in Section 5.2.13, the enterprise will keep a 3-week inventory of manufactured feed in year 2003, and a 2-week stock thereafter. The last stock of feed will be sold out in year 2013, during the liquidation period.

Opening Inventory: The opening feed inventory is taken from the previous year. Since the plant operation starts in year 2003, there is no opening stock in years 2002 and 2003. Let's look at the opening feed inventory of year 2004, which is transferred from the end of year 2003 and estimated as 10,385 tons, which was the result of multiplying the 360,000-ton capacity by the actual capacity utilization of 50% and also by 3 (weeks) over 52 (weeks a year).

Closing Inventory: The same logic applies to the feed closing inventory as in the case of the feed ingredients inventory. The only differences are in the entry of the actual capacity utilization factor, which is now the current capacity utilization rather than the next year's factor, and the measurement of the inventory stock, which is now counted in weeks rather than in months.

$$\text{Closing Inventory}_{\text{YearX}} \text{ (tons/year)} = \text{Design Annual Feed Ingredients Requirement (tons/year)} * \text{Actual Capacity Utilization Factor}_{\text{YearX}} (\%) * \left(\frac{\text{Inventory}_{\text{YearX}} \text{ (weeks)}}{52 \text{ (weeks)}} \right)$$

$$\text{Closing Inventory}_{2004} = 360,000 * 70.0\% * (2 / 52) = 9,692 \text{ tons/year}$$

Production: This is the actual amount of feed produced during a year. The correct way to model this line is to multiply the design capacity of the plant by the actual capacity utilization factor in the current year:

$$\text{Production}_{\text{YearX}} (\text{tons/year}) = \text{Design Capacity} (\text{tons/year}) * \text{Actual Capacity Utilization Factor}_{\text{YearX}} (\%)$$

$$\text{Production}_{2004} = 360,000 * 70.0\% = 252,000 \text{ tons/year}$$

Sales: At this point, it becomes crystal clear that sales are not necessarily equal to the total production in a year, simply because some portion of the feed produced should be kept on hands. Thus, the sales can be found by subtracting the stock of closing inventory from the sum of the opening inventory and current production:

$$\text{Sales}_{\text{YearX}} (\text{tons/year}) = \text{Opening Inventory}_{\text{YearX}} + \text{Production}_{\text{YearX}} - \text{Closing Inventory}_{\text{YearX}}$$

$$\text{Sales}_{2004} = 10,385 + 252,000 - 9,692 = 252,692 \text{ tons/year}$$

Value of Closing Inventory: In the case of feed inventory, it is not needed to calculate the values of opening inventory, production and sales. The only useful line here is the value of the closing inventory, which is required to estimate the annual change in the stock of feed inventory. At the end of the year, the relevant price to measure the inventory stock is the current weighted average price of feed:

$$\text{Value of Closing Inventory, Rand}_{\text{YearX}} = \text{Closing Inventory}_{\text{YearX}} (\text{tons}) * P_{\text{W, YearX}}^{\text{Feed}} (\text{Rand/ton})$$

$$\text{Value of Closing Inventory}_{2004} = 9,692 * 1,281 = 13,164,279 \text{ Rand}_{2004}$$

The final use of the constructed feed inventory schedule is again twofold: the production and sales quantities will enter into the Table of Production and Sales, and the values of closing inventory is used for calculation of the “change in the feed inventory”. The change in the feed inventory represents the cashflow equivalent of holding the feed inventory stock.

Change in Feed Inventory: The change in the feed inventory is the adjustment that reconciles the quantity purchased and sold in a year, and it is computed as:

$$\Delta \text{Feed Inventory, Rand}_{\text{YearX}} = \text{Value of Closing Inventory}_{\text{YearX-1}} - \text{Value of Closing Inventory}_{\text{YearX}}$$

$$\Delta \text{Feed Inventory}_{2004} = 13,306,212 - 13,164,279 = 141,933 \text{ Rand}_{2004}$$

5.9 Table of Production and Feed Sales

Such a table is typically needed to show explicitly the quantities of the different outputs being produced, sold and kept in inventories. It is convenient to have all the information about different products in one place, and this table is the logical place to organize this information. Table 8 shows the Table of Production and Sales discussed here.

Production: This section shows the total quantity of the feed and production of feed by type. All the figures are quantities of feed, expressed in metric tons, produced a year. The amount of a specific type of feed produced in a year is calculated as the total production of feed in that year, taken from feed inventory schedule, times the share of this feed type in the total production, taken from the Capacity Utilization Schedule:

$$\begin{aligned}\text{Production}_{\text{FeedN, YearX}} (\text{tons/year}) &= \text{Production}_{\text{YearX}} (\text{tons/year}) * \text{Share}_{\text{FeedN, YearX}} (\%) \\ \text{Production}_{\text{Beef, 2004}} &= 252,000 * 40.0\% = 100,800 \text{ tons/year}\end{aligned}$$

Feed Inventory: The purpose of this section is to show the amount of the closing inventory for the different types of feed being produced. It is useful to have such a detailed annual inventory schedule for the inventory management. The correct way to model such a schedule is to start with the estimated closing feed inventory, taken from the inventory schedule, and to multiply it by the share of this feed type in the total production, taken from the capacity utilization schedule:

$$\begin{aligned}\text{Feed Inventory}_{\text{FeedN, YearX}} (\text{tons/year}) &= \text{Feed Inventory}_{\text{YearX}} (\text{tons/year}) * \text{Share}_{\text{FeedN, YearX}} (\%) \\ \text{Feed Inventory}_{\text{Beef, 2004}} &= 9,692 * 40.0\% = 2,908 \text{ tons/year}\end{aligned}$$

Feed Sales: Since the total feed sales have been already estimated in the Feed Inventory Schedule, a detailed forecast for each feed type is needed now. Note that this is a schedule for quantities, not the sales receipts yet. The calculation of the quantity of a specific type of feed sold in a year is based on the total quantity sold in that year times the share of this feed type in the total production:

$$\begin{aligned}\text{Feed Sales}_{\text{FeedN, YearX}} (\text{tons/year}) &= \text{Sales}_{\text{YearX}} (\text{tons/year}) * \text{Share}_{\text{FeedN, YearX}} (\%) \\ \text{Feed Sales}_{\text{Beef, 2004}} &= 252,692 * 40.0\% = 75,808 \text{ tons/year}\end{aligned}$$

Sales Receipts: Having estimated the quantity of feed sold by type and given the projections of the different feed prices, enables the analyst to forecast the sales receipts for each type of feed. The obvious calculation is to multiply the quantity of feed sold per type by their respective nominal prices:

$$\text{Sales Receipts}_{\text{FeedN, YearX}} (\text{Rand/year}) = \text{Feed Sales}_{\text{FeedN, YearX}} (\text{tons/year}) * P^{\text{Nominal}}_{\text{FeedN, YearX}} (\text{Rand/ton})$$

$$\text{Sales Receipts}_{\text{Beef}, 2004} = 75,808 * 1,448 = 109,769,411 \text{ Rand}_{2004}/\text{year}$$

The total receipts from all different types of feed are the sum of the sale receipts for beef, layer, broiler, pig, game and aqua feed:

$$\begin{aligned} \text{Total Sales Receipts}_{\text{YearX}} &= \sum_N (\text{Sales Receipts}_{\text{FeedN}, \text{YearX}}) \\ \text{Total Sales Receipts}_{2004} &= 343,211,553 \text{ Rand}_{2004} \end{aligned}$$

5.10 Depreciation Schedule

Given the fact that most of the tangible assets lose their value over time, such a schedule becomes useful to estimate the cost of the wear and tear of the assets. Table 9 contains the estimation of economic depreciation, residual values of the plant's assets and tax depreciation expense. The financial depreciation expense is not used in the financial cashflow statements. At the same time, two other estimates of depreciation expense are needed for each year of the project's life.

First, an economic depreciation expense needs to be estimated in order to calculate the residual, or "salvage" values, at the end of the project's life. Second, a tax depreciation expense needs to be calculated to determine the taxable income and income tax liabilities of the enterprise. Although, these two objectives seem to be similar in their nature, they do require a different way of modeling and, therefore, two separate schedules are modeled to address these needs.

5.10.1 Tax Depreciation

The purpose of this schedule is to estimate the "depreciation" expense for the income tax statement. The total depreciation expense in a year is a sum of the depreciation of all the assets. Thus, in order to arrive at the total depreciation allowance, it is need to calculate the depreciation per each type of plant assets. Three types of the feed plant assets are allowed to depreciate from the tax point of view: construction, equipment and machinery, and vehicles. The land, freight and traveling expenses are not permitted to be included in the calculation of tax depreciation.

Historical Cost: The very first column, called historical cost shows the asset's cost eligible for tax depreciation. Thus, the actual construction costs amount to 37,807,744 Rand and since the tax code permits 100% of these costs to be depreciated, the resulting value is also 37,807,744 Rand₂₀₀₂.

The same computation of eligible historical cost is performed for the equipment and vehicles, but an additional action is needed to deduct the grant amount, which is deducted from the costs of the equipment items but not deducted from the costs of office equipment, vehicles, freight and traveling expenses. Recall that in the summary table of the investment costs, there was a section for the equipment items with tax depreciation deduction, described in Section 5.4.6. Now it is time to use the values from that section. The historical cost of every equipment item must be reduced by the value of grant per that item, which can be taken from the summary table of the investment costs:

$$\text{Tax Base Value}_{\text{ItemN}} (\text{Rand}_{2002}) = (\text{Total Cost}_{\text{ItemN}} - \text{Grant Deduction}_{\text{ItemN}}) * \% \text{Historical Cost}_{\text{ItemN}}$$

$$\text{Tax Base Value}_{\text{Feed Production Equipment}} = (17,481,934 - 1,211,804) * 100\% = 16,270,130 \text{ Rand}_{2002}$$

Annual Depreciation Expense: The total annual depreciation “expense”, which is not an actual expense from cashflow point of view but it is treated as an expense for tax purposes, is a sum of the annual depreciation of construction assets, equipment and vehicles. There is no depreciation for land, which does not lose value but even tends to appreciate over time. The treatment of land in financial and economic analysis will be discussed in the next section alongside with the discussion of the economic depreciation.

A uniform formula is used to estimate the annual depreciation of each asset, which spells that the amount of annual depreciation, in real terms, is equal to the initial cost of the asset ($\text{Historical Cost}_{\text{ItemN}}$) divided by the number of years of its tax life. Because the current tax regulation does not provide for inflation adjustment of the tax depreciation expense, the resulting real annual value must not be inflated⁴. The correct way to model the nominal tax depreciation expense is shown in the formula below, which yields a fixed nominal value of depreciation expense in each year:

$$\text{AD}^{\text{Nominal}}_{\text{YearX, ItemN}} (\text{Rand}_{\text{YearX}}) = \text{Historical Cost}_{\text{ItemN}} (\text{Rand}_{2002}) / \text{Tax Life}_{\text{ItemN}} (\text{years})$$

$$\text{AD}^{\text{Nominal}}_{2003, \text{Construction}} = 37,807,744 / 20 = 1,890,387 \text{ Rand}_{2003}$$

The resulting nominal annual depreciation can be used in the Income Tax Statement. In order to make the depreciation schedule adjustable to changes in the length of the tax life, a somewhat complex MS-Excel function is used. This formula ensures that the annual depreciation appears only in the years of asset’s tax life. If the current year is before or beyond the tax life period of a certain asset, the value of zero is assigned to that year annual depreciation:

⁴ For a complete set of the regulations governing the tax treatment of depreciation expense, see SARS (2002).

$$AD^{\text{Nominal}}_{\text{YearX, ItemN}} = \text{IF}(\text{AND}(\text{YearX} < (2003 + \text{Tax Life}_{\text{ItemN}}), \text{YearX} > 2002), \text{Tax Base Value}_{\text{ItemN}} / \text{Tax Life}_{\text{ItemN}} * I^{\text{D}}_{\text{YearX}}, 0)$$

The annual depreciation expense adjusted for grant amount is a simple summation of the results. This line will enter the income tax statement as depreciation expense of the feed plant.

5.10.2 Economic Depreciation

The purpose of this schedule is to estimate the residual values of the plant assets at the end of the project's life. The computational difference between the tax and economic depreciation schedules is that the economic depreciation does not focus on the annual depreciation and, instead, it estimates the residual value of an asset. The residual value of any asset can be found as:

$$\text{Residual Value}_{\text{ItemN}} = \text{Initial Cost}_{\text{ItemN}} - \text{Accumulated Depreciation}_{\text{ItemN}}$$

Initial Costs: To incorporate the above formula into the economic schedule, a few prior steps should be taken. The very first column in this schedule contains the initial cost of the plant's assets to be depreciated over time. All assets are included and their cost values are taken directly from the summary of the investment costs table with the exception of the freight and transportation expenses which are excluded. Despite the fact that some of the equipment items had "mounting" expenses, which are not physically present after the launch of the plant, it is assumed that such expenses became embedded into the values of the corresponding assets.

Liquidation Values: Given that the initial costs are already established, now it is needed to find the amount of accumulated depreciation for each asset, which is, in real terms, simply a sum of all the annual depreciations over the project life:

$$\text{Accumulated Depreciation}_{\text{ItemN}} (\text{Rand}_{2002}) = \sum_X (AD^{\text{Real}}_{\text{YearX, ItemN}}).$$

The real annual depreciation is, in turn, calculated as the initial cost of the asset ($\text{Initial Cost}_{\text{ItemN}}$) divided by the number of years of its economic life. The resulting real annual value does not need to be inflated because this annual depreciation is measured in real terms in order to reflect the actual wear and tear of the asset. These transactions can be expressed as:

$$AD^{\text{Real}}_{\text{ItemN}} (\text{Rand}_{2002}) = \text{Initial Cost}_{\text{ItemN}} (\text{Rand}_{2002}) / \text{Economic Life}_{\text{ItemN}} (\text{years})$$

$$AD^{\text{Real}}_{2002, \text{Construction}} = 37,807,744 / 30 = 1,056,099 \text{ Rand}_{2002}$$

$$\text{Accumulated Depreciation}_{\text{Construction}} = \sum_{10} (1,056,099 \text{ Rand}_{2002}) = 12,602,581 \text{ Rand}_{2002}$$

$$\text{Residual Value}^{\text{Real}}_{\text{Construction}} = 37,807,744 - 12,602,581 = 25,205,163 \text{ Rand}_{2002}$$

A residual value of such an amount is expected from the calculations because the economic life of construction assets is taken as 30 years while the project operates only 10 years, which is only one third of its useful life. Therefore, the residual value, in real terms, is simply a third of the initial cost of construction. Because the cashflows are modeled in nominal rather than real prices, the resulting real residual value must be inflated to the price level of the liquidation year:

$$\begin{aligned} \text{Residual Value}^{\text{Nominal}}_{\text{ItemN}} (\text{Rand}_{\text{LiquidationYear}}) &= \text{Residual Value}^{\text{Real}}_{\text{ItemN}} (\text{Rand}_{2002}) * I^{\text{D}}_{\text{LiquidationYear}} \\ \text{Residual Value}^{\text{Nominal}}_{\text{Construction}} &= 25,205,163 * 1.90 = 47,846,924 \text{ Rand}_{2013} \end{aligned}$$

The final destination of the calculated residual values is the revenue-side section of the cashflow statements. The residual values are not included into the Income Tax Statement. A few issues should be pointed for the analyst to reduce the number of questions that may arise.

The most common pitfall is related to the treatment of land. Most people agree that land does not depreciate under usual circumstances, but the real issue is when the price of land increases over time and the analyst has to decide whether to include this appreciation as a project benefit or not. A good discussion on this issue is available in *Manual (2003)*. What it means is that the analyst should clearly see if the appreciation, or depreciation, in the real value of land is caused by the project. If this is the case then such a real change in the value of the land should be included in the residual value of the land. However, if the real appreciation (depreciation) of land takes place due to the forces, external to the project, then the changes in the land value should not be included as a part of the residual values.

The feed project is not a type of business that would substantially improve or spoil the land, and therefore no real change in the value of land is expected over time. Thus, the annual depreciation of land is also zero.

To calculate the residual value of land, the analyst should use the same formula as was utilized for the estimation of the annual tax depreciation. This formula allows the analyst to have a flexible economic depreciation schedule, with a provision for changing the length of the economic life. Such a formula would have a form:

$$\begin{aligned} AD^{\text{Real}}_{\text{YearX, ItemN}} &= \\ &= \text{IF}(\text{AND}(\text{YearX} < (2003 + \text{Economic Life}_{\text{ItemN}}), \text{YearX} > 2002), \text{Initial Cost}_{\text{ItemN}} / \text{Economic Life}_{\text{ItemN}}, 0) \end{aligned}$$

This approach will keep the residual values to a manageable detail, and should correspond to the items of the investment costs. In the case of the feed project, the investment costs data are quite lengthy and a reasonable consolidation can be reached by grouping similar items together. For

instance, the equipment items are consolidated in only four categories and further tables are based on these category totals. Also, it can be useful to see the composition of the investment costs and residual values, so it is advisable not to aggregate the data to a single cashflow item, unless necessary.

5.11 Schedule of Labor, Electricity and Water Expenses

This schedule is constructed in order to forecast three operating expenses: labor, electricity and water. In fact, each of them can be taken as a separate schedule but to keep the spreadsheet simple, they are grouped together because their estimation is somewhat similar. Table 10 combines the schedules for the labor, electricity, water and other operating expenses. The end product of each section here is to have a forecast of annual nominal expenditure on labor, electricity and water.

5.11.1 Labor Expenses

Typically, a project employs a number of people that can be classified into three categories as unskilled labor, skilled labor and management. The same division can be done for the employees at the feed plant. Referring back to Section 5.2.9, let's recall that the project will employ 12 unskilled workers in year 2002, 16 workers in 2003 and 20 workers thereafter with a gross monthly salary of 2,400 Rand. Skilled and semi-skilled personnel will consist of four employees with a monthly salary of 14,000 Rand. The permanent management team will be staffed with three professional engineers, who will be transferred from the foreign country. Their monthly salaries are assumed to be 18,000 Rand per person. All salaries are expected to grow by 0.5% a year in real terms, and also to be adjusted for the annual rate of inflation.

Since all the three labor categories are modeled in an identical way, let's take the example of unskilled and semi-skilled labor to illustrate the computational techniques. The starting point here is the data on the monthly salary, number of employees, and real wage growth rate. The final product of labor schedule is the annual nominal labor expense, i.e. gross payroll.

Annual Salary: This column is created to convert the monthly salaries into annual equivalent per employee, expressed in real 2002-year prices. This simple conversion takes the gross monthly salary and multiplies it by 12 months a year, for example, this was done for unskilled and semi-skilled labor:

$$\text{Annual Salary}_{\text{Unskilled \& Semi-Skilled}} (\text{Rand}_{2002}/\text{year}) = \text{Salary}_{\text{Unskilled \& Semi-Skilled}} (\text{Rand}_{2002}/\text{month}) * 12$$

$$\text{Annual Salary}_{\text{Unskilled \& Semi-Skilled}} = 2,400 * 12 = 28,800 \text{ Rand}_{2002}/\text{year}$$

The resulting real annual salary is shown in the column, and it will serve as a base for the estimation of the nominal annual payment in the consequent years.

Real Wage Index: Similarly to the price index in Table 2, a wage index is created in order to show how the real wage, without inflation adjustment, would grow over years. Because all the three labor categories are subject to the same real wage increase, it is convenient to build such an index and use it for all labor projections. Since year 2002 is taken as year-zero for the feed project, its index is set to one representing the starting point of the index. In all the consequent years, the index is calculated by applying the defined growth rate to the value of the previous year index:

$$WI_{\text{YearX}} = WI_{\text{YearX-1}} * (1 + \text{Wage Growth Rate}^{\text{Real}})$$

$$WI_{2004} = 1.005 * (1 + 0.5\%) = 1.010$$

Annual Nominal Payment: This is the nominal gross payroll for each labor category, and is based on the calculated real annual salary, real wage index, domestic inflation, and number of employees:

$$\text{Annual Payment}^{\text{Nominal}}_{\text{CategoryM, YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) =$$

$$= \text{Annual Salary}_{\text{CategoryM, 2002}} (\text{Rand}_{2002}/\text{employee}) * WI_{\text{YearX}} * n_{\text{CategoryM, YearX}} (\text{employees}) * I^{\text{D}}_{\text{YearX}}$$

$$\text{Annual Payment}^{\text{Nominal}}_{\text{Unskilled \& Semi-Skilled, 2004}} = 28,800 * 1.010 * 16 * 1.12 = 522,945 \text{ Rand}_{2004}/\text{year}$$

The calculation of annual expenses for skilled labor and management is carried out in the same way as for unskilled labor. The total labor expenditure a year is a sum of the unskilled, skilled and management expenses.

5.11.2 Electric Power

The municipality tariffs for electric power were already stated in Section 5.2.11, and the total power requirement for the feed equipment and machinery was worked out in the Summary of Investment Costs, Table 3H. It is now possible to translate all the data into cash expenditures. The only difficulties seen here are that the municipality bills industrial consumers monthly rather than annual, and the billing is based on an increasing “step” tariff.

Tariff Index: Because it is expected that the real tariff will grow, on the average, by 0.5% annually, such an index will be useful. The index value in year 2002 is one, and in the consequent years it is computed in the same way as the real wage index:

$$TI_{\text{YearX}} = TI_{\text{YearX-1}} * (1 + \text{Tariff Growth Rate}^{\text{Real}})$$

$$TI_{2004} = 1.005 * (1 + 0.5\%) = 1.010$$

Power Consumption: These two lines represent the amount of energy consumed in a year, and in a month. The yearly consumption is calculated as a product of the total energy requirement at the full capacity of the plant, actual capacity utilization factor, and number of working hours in a year:

$$\begin{array}{ccccccc} \text{Annual Power} & & \text{Energy} & & \text{Actual Capacity} & & \text{Working} \\ \text{Consumption}_{\text{YearX}} & = & \text{Requirement} & * & \text{Utilization} & * & \text{Hours a} \\ \text{(kWh/year)} & & \text{(KWh)} & & \text{Factor}_{\text{YearX}} (\%) & & \text{Week} \\ & & & & & & \text{Weeks a} \\ & & & & & & \text{Year} \end{array}$$

The power consumption per month is simply the annual power consumption divided by 12 months. For instance, the monthly power consumption in year 2004 can be found as:

$$\text{Annual Power Consumption}_{2004} = 2,248 * 70\% * 45 * 52 = 3,682,601 \text{ kWh/year}$$

$$\text{Monthly Power Consumption}_{2004} = 3,682,601 \text{ kWh/year} / 12 \text{ months} = 306,883 \text{ kWh/month}$$

The tariffs set by the municipality provide for a two-level monthly consumption charges: energy consumed up to 100,000 kWh is charged at 0.20 Rand/kWh, and anything above that is subject to tariff of 0.18 Rand/kWh. The total monthly consumption has to be disintegrated into these two categories in order to be charged a corresponding tariff. This can be modeled by using a MS-Excel “MIN” function, which returns the minimum of the given parameters.

$$\text{Monthly Power Consumption}^{\leq 100,000 \text{ kWh}}_{\text{YearX}} = \text{MIN}(\text{Monthly Power Consumption}_{\text{YearX}}, 100,000)$$

$$\text{Monthly Power Consumption}^{\leq 100,000 \text{ kWh}}_{2004} = \text{MIN}(306,883, 100,000) = 100,000 \text{ kWh/month}$$

The remaining gap between the total monthly consumption and the 100,000 kWh benchmark is simply the difference between the two energy amounts:

$$\begin{array}{ccccc} \text{Monthly Power} & & \text{Monthly Power} & & \text{Monthly Power} \\ \text{Consumption}^{>100,000 \text{ kWh}}_{\text{YearX}} & = & \text{Consumption}_{\text{YearX}} & - & \text{Consumption}^{<100,000 \text{ kWh}}_{2004} \end{array}$$

$$\text{Monthly Power Consumption}^{>100,000 \text{ kWh}}_{2004} = 306,883 - 100,000 = 206,883 \text{ kWh/month}$$

Power Charges: Thus, the annual power charge can be estimated by applying the tariff on the energy consumed, and by adjusting the result for the real growth in electricity tariffs. A further adjustment is needed to account for the rate of annual inflation. The formula, which combines all of this, has the following form:

$$\begin{array}{c} \text{Power} \\ \text{Charge} \\ \text{(Rand}_{\text{YearX}} / \\ \text{month)} \end{array} = \left(\begin{array}{cc} \text{Monthly} & \text{Tariff} \\ \text{Power} & \leq 100,000 \text{ kWh} \\ \text{Consumption} & \text{(Rand}_{2002} / \\ < 100,000 \text{ kWh} & \text{kWh)} \\ \text{YearX} & \\ \text{(kWh/month)} & \end{array} * \right. + \left. \begin{array}{cc} \text{Monthly} & \text{Tariff} \\ \text{Power} & > 100,000 \text{ kWh} \\ \text{Consumption} & \text{(Rand}_{2002} / \\ > 100,000 \text{ kWh} & \text{kWh)} \\ \text{YearX} & \\ \text{(kWh/month)} & \end{array} * \right) * TI_{\text{YearX}} * I^D_{\text{YearX}}$$

$$\text{Power Charge}^{\text{Nominal}}_{2004} = (100,000 * 0.20 + 206,883 * 0.18) * 1.010 * 1.12 = 64,958 \text{ Rand}_{2004}/\text{month}$$

Apart from the kilowatt-hour power charges, there are also service and demand charges, billed by the municipality to the industrial consumers like the feed plant. As indicated in Section 5.2.11, the monthly service charge is 95 Rand and it is expected to prevail on the same level in real terms. The nominal monthly service charge can be found by multiplying the real service charge by the current domestic price index:

$$\begin{aligned} \text{Service Charge}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{month}) &= \text{Service Charge}^{\text{Real}}_{2002} (\text{Rand}_{\text{YearX}}/\text{month}) * I^{\text{D}}_{\text{YearX}} \\ \text{Service Charge}^{\text{Nominal}}_{2004} &= 95 * 1.12 = 101.1 \text{ Rand}_{2004}/\text{month} \end{aligned}$$

The demand charge is based on the amount of kilowatt-ampere consumed by the plant. Recall that the full capacity plant load would result in 200 kVA power demand. The current tariff is quoted as 50 Rand/month per kVA supplied to the plant. Therefore, the formula to calculate a monthly nominal demand charge would look like:

$$\begin{aligned} \text{Demand Charge}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{month}) &= \frac{\text{Demand Charge}^{\text{Real}}_{2002} (\text{Rand}_{\text{YearX}}/\text{month}/\text{kVA}) * \text{kVA Requirement (kVA)} * \text{Actual Capacity Utilization Factor}_{\text{YearX}} (\%)}{1} * I^{\text{D}}_{\text{YearX}} \\ \text{Demand Charge}^{\text{Nominal}}_{2004} &= 50 * 200 * 70\% * 1.12 = 7,865 \text{ Rand}_{2004}/\text{month} \end{aligned}$$

The total annual nominal electricity expenditure is a sum of the power, service and demand charges, which also have to be translated into their annual equivalents:

$$\begin{aligned} \text{Electricity Expenses}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) &= \left(\frac{\text{Power Charge}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{month})}{1} + \frac{\text{Service Charge}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{month})}{1} + \frac{\text{Demand Charge}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{month})}{1} \right) * 12 (\text{months}) \\ \text{Electricity Expenses}^{\text{Nominal}}_{2004} &= (64,958 + 101.1 + 7,865) * 12 = 875,098 \text{ Rand}_{2004}/\text{year} \end{aligned}$$

5.11.3 Water Expenses

The water services are also provided by the municipality, and a step tariff is charged to industrial water users like the feed plant. The plant design water consumption is 60,000 m³, which is subject to its actual capacity utilization factor. The current water tariffs are such that the first 30 m³/month is charged 5.00 Rand/m³, the next 20 m³/month is charged 6.50 Rand/m³, the following 50 m³/month is charged 7.50 Rand/m³, the next 19,900 m³/month is charged 8.00 Rand/m³, and any

amount above that is subject to a tariff of 7.00 Rand/m³. The tariffs will have to be adjusted for the annual inflation, and, in addition, a real tariff growth rate of 1.0% per annum is expected to prevail over the project's life.

To model the real tariff growth, a tariff index (WT_{YearX}) is used once again. The total quantity of water consumed a year is found as the water requirement at the full plant capacity, multiplied by the actual capacity utilization factor. Table 10 demonstrates this calculation. The monthly water consumption is simply the annual consumption divided by 12 months.

$$\begin{array}{ccccc} \text{Annual Water} & & \text{Water} & & \text{Actual Capacity} \\ \text{Consumption}_{YearX} & = & \text{Requirement} & * & \text{Utilization} \\ (m^3/year) & & (m^3/year) & & \text{Factor}_{YearX} (\%) \end{array}$$

$$\text{Annual Water Consumption}_{2004} = 60,000 * 70\% = 42,000 \text{ m}^3/\text{year}$$

$$\text{Monthly Water Consumption}_{2004} (W^{Total}_{2004}) = 42,000 / 12 = 3,500 \text{ m}^3/\text{year}$$

Monthly Water Consumption: The next step is to model the step tariff, which requires separating the quantity of water consumed into the different tariff brackets. The monthly water consumption must be a sum of all these quantities, or:

$$\text{Monthly Water Consumption}_{YearX} (W^{Total}) = W^{<30} + W^{30 < W < 50} + W^{50 < W < 100} + W^{100 < W < 19,000} + W^{>19,000}$$

Then, a few lines can do this job by using “MIN” function of MS-Excel:

$$\text{First } 30 \text{ m}^3/\text{month: } W^{<30} = \text{MIN}(30, W^{Total})$$

$$\text{Next } 20 \text{ m}^3/\text{month: } W^{30 < W < 50} = \text{MIN}(20, W^{Total} - W^{<30})$$

$$\text{Next } 50 \text{ m}^3/\text{month: } W^{50 < W < 100} = \text{MIN}(50, W^{Total} - W^{<30} - W^{30 < W < 50})$$

$$\text{Next } 19,000 \text{ m}^3/\text{month: } W^{100 < W < 19,000} = \text{MIN}(19,900, W^{Total} - W^{<30} - W^{30 < W < 50} - W^{50 < W < 100})$$

$$\text{Thereafter: } W^{>19,000} = W^{Total} - W^{<30} - W^{30 < W < 50} - W^{50 < W < 100} - W^{100 < W < 19,000}$$

An illustrative computation can be performed for the monthly water consumption in year 2004:

$$\text{First } 30 \text{ m}^3/\text{month: } W^{<30} = 30 = \text{MIN}(30, 3,500)$$

$$\text{Next } 20 \text{ m}^3/\text{month: } W^{30 < W < 50} = 20 = \text{MIN}(20, 3,500 - W^{<30})$$

$$\text{Next } 50 \text{ m}^3/\text{month: } W^{50 < W < 100} = 50 = \text{MIN}(50, 3,500 - W^{<30} - W^{30 < W < 50})$$

$$\text{Next } 19,000 \text{ m}^3/\text{month: } W^{100 < W < 19,000} = 3,400 = \text{MIN}(19,900, 3,500 - 20 - 30 - 50)$$

$$\text{Thereafter: } W^{>19,000} = 0 = 3,500 - 20 - 30 - 50 - 3,400$$

$$\text{Monthly Water Consumption}_{2004} (W^{Total}) = 20 + 30 + 50 + 3,400 + 0 = 3,500 \text{ m}^3/\text{month}$$

Monthly and Annual Water Expenses: The monthly water expense, in real terms, is a sum of the water consumed in the different brackets multiply by their corresponding tariff rates (T^{Water}), and adjusted for the growth in the real tariff:

$$\begin{aligned}
& \text{Monthly Water Expense}^{\text{Real}}_{\text{YearX}} (\text{Rand}_{2002}/\text{month}) = \\
& = (W^{<30} * T^{<30} + W^{30 < W < 50} * T^{30 < W < 50} + W^{50 < W < 100} * T^{50 < W < 100} + W^{100 < W < 19,000} * T^{100 < W < 19,000} + W^{>19,000} * T^{>19,000}) * W T_{\text{YearX}} \\
& \text{Monthly Water Expense}^{\text{Real}}_{2004} = \\
& = (30 * 5.0 + 20 * 6.5 + 50 * 7.5 + 3,400 * 8.0 + 0 * 7.0) * 1.020 = 28,415 \text{ Rand}_{2002}/\text{month}
\end{aligned}$$

This derived real monthly water expense has to be translated into its annual nominal equivalent, which can be done by multiplying the result by the domestic price index and by the number of months a year:

$$\begin{aligned}
& \text{Annual Water Expense}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) = \\
& = \text{Monthly Water Expense}^{\text{Real}}_{\text{YearX}} (\text{Rand}_{2002}/\text{month}) * I^D_{\text{YearX}} * 12 (\text{months}) \\
& \text{Annual Water Expense}^{\text{Nominal}}_{2004} = 28,415 * 1.12 * 12 = 383,124 \text{ Rand}_{2004}/\text{year}
\end{aligned}$$

5.11.4 Schedule of Other Operating Expenses

Apart from the labor, electric and water expenses, there are a number of the cash outlays. Table 10 shows the future projections of the operating costs. The reason why these expenses are grouped together is their similarity in estimation. Section 5.2.10 stated a number of annual operating costs, and they are not expected to vary from year to year in real terms. However, an adjustment for domestic inflation is necessarily. For the majority of the expenses here, the formula below will be used, and if the calculation of some of the expenses involves more than that, an explanation will be given. The basic formula is:

$$\begin{aligned}
& \text{Expense}^{\text{Nominal}}_{\text{ItemN, YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) = \text{Expense}^{\text{Real}}_{\text{ItemN, 2002}} (\text{Rand}_{2002}/\text{year}) * \frac{\text{Actual Capacity}}{\text{Utilization Factor}_{\text{YearX}} (\%)} * I^D_{\text{YearX}}
\end{aligned}$$

All expenses, except equipment mechanic service, are estimated by the formula stated above, and an illustration of this can be done with the example of office accommodation, and transportation and storage in year 2004:

$$\begin{aligned}
& \text{Office Accommodation}^{\text{Nominal}}_{2004} = 1,200,000 * 70\% * 1.12 = 943,824 \text{ Rand}_{2004}/\text{year} \\
& \text{Transportation and Storage}^{\text{Nominal}}_{2004} = 2,000,000 * 70\% * 1.12 = 1,573,040 \text{ Rand}_{2004}/\text{year}
\end{aligned}$$

Equipment Mechanic Service: This expense can be estimated by using the main formula with a little modification due to the fact that the cost of this service has to be derived from the equipment cost:

$$\begin{aligned}
& \text{Equipment Mechanic Service}^{\text{Real}}_{2002} = \frac{\text{Total Equipment Cost}}{\text{Service}^{\text{Real}}_{2002}} * \frac{\text{Share of}}{\text{Mechanic}} * \frac{\text{Actual Capacity}}{\text{Utilization}} * I^D_{\text{YearX}}
\end{aligned}$$

(Rand₂₀₀₂/year) (Rand₂₀₀₂/year) Service (%) Factor_{YearX} (%)

Equipment Mechanic Service^{Real}₂₀₀₂ = 47,566,700 * 2.5% * 50% * 1.00 = 630,259 Rand₂₀₀₂/year

Equipment Mechanic Service^{Nominal}₂₀₀₄ = 47,566,700 * 2.5% * 70% * 1.12 = 935,304 Rand₂₀₀₄/year

5.12 Working Capital Schedule

Such a schedule is typically needed in order to model the annual changes in the working capital, and Table 11 illustrates the modeling of working capital schedule. Usually, the working capital includes accounts receivable, accounts payable and cash balance. The estimates of the amount of such account were discussed in Section 5.2.8.

Accounts Receivable: These accounts represent the amount of cash outstanding from the sales, and it is expected that accounts receivable will be equal to 2 week of the total sales, on the average. Thus, the total amount of accounts receivable, which are always measured in the current nominal prices, is found by the formula:

$$AR_{YearX} \text{ (Rand}_{YearX}\text{/year)} = \text{Total Sales Receipts}_{YearX} \text{ (Rand}_{YearX}\text{/year)} * [AR^{Adjusted}_{YearX} \text{ (weeks/year)} / 52]$$

$$AR_{2004} = 343,211,553 * (2 / 52) = 13,200,444 \text{ Rand}_{2004}\text{/year}$$

Because the total feed sales are composed of several feed types, a further detailed separation is also made in order to estimate the amount of accounts receivable per each feed type. It is computed as the total accounts receivable multiplied by the share of the particular feed type in the production:

$$AR_{FeedN, YearX} = AR_{YearX} * \%Share_{FeedN, YearX}$$

However, the estimated amount of accounts receivable is again a “stock” of cash sitting idle in the accounting books, while the cashflow statements operate with “flows” of cash, which means that the computed accounts receivable has to be converted into its cashflow equivalent, or “change in accounts receivable”. Note that such a change is computed as the previous’ year accounts receivable minus the current’s year accounts receivable, and any increase in their amount must have a negative impact on the cashflows:

$$\Delta AR_{YearX} = AR_{YearX-1} - AR_{YearX}$$

$$\Delta AR_{2004} = 8,359,030 - 13,200,444 = -4,841,414 \text{ Rand}_{2004}\text{/year}$$

Again, a detailed break-down of the total change in accounts receivable is done per feed type, by using a similar formula: $\Delta AR_{FeedN, YearX} = \Delta AR_{YearX} * \%Share_{FeedN, YearX}$.

Accounts Payable: Because the amount of accounts payable is linked to the total direct operating costs, a line with such costs is useful to show explicitly. The accounts payable are expected to be, on the average, outstanding for 1 week a year, based on the total direct operating costs.

The “direct operating costs” include the cost of feed ingredients, labor, electricity, water, transportation and storage, and equipment mechanic service. The “indirect operating costs” cover all other expenses, such as administration, advertising, audit and accounting services, office and transportation services, business travel and transportation. Thus, the direct operating costs for year 2004 ($DOC^{Nominal}_{2004}$) would amount to 298,912,188 Rand₂₀₀₄, and the accounts payable can be estimated as:

$$AP_{YearX} (Rand_{YearX}/year) = DOC_{YearX} (Rand_{YearX}/year) * [AP (weeks/year) / 52 (weeks/year)]$$

$$AP_{2004} = 298,912,188 * (1 / 52) = 5,748,311 \text{ Rand}_{2004}/year$$

The change in accounts payable is also computed as the previous’ year accounts payable minus the current’s year accounts payable, and any increase in their amount must have a negative impact on the expenditures, i.e. a positive impact on the cashflows, since the change in accounts payable is usually placed on the cost side:

$$\Delta AP_{YearX} = AP_{YearX-1} - AP_{YearX}$$

$$\Delta AP_{2004} = 3,899,721 - 5,748,311 = -1,848,591 \text{ Rand}_{2004}/year$$

Cash Balances: The amount of cash balance is also linked to the annual direct operating costs, and it is expected to be, on the average, 2.0% of these costs:

$$CB_{YearX} (Rand_{YearX}/year) = DOC_{YearX} (Rand_{YearX}/year) * \%Share \text{ of } CB (\%)$$

$$CB_{2004} = 298,912,188 * 2.0\% = 5,978,244 \text{ Rand}_{2004}/year$$

The difference between the accounts payable and cash balances is in their impact on the project’s cashflows. While any delay in the transfer of cash from the project to its suppliers is beneficial for the project, an increase of the amount of cash balance implies, other things being constant, that this cash is withdrawn from another productive use and must be treated as a negative cash flow. Keep on mind that because the cash balances are placed on the expenditure side of cashflows, the expected sign of an increase in the cash balances is a positive contribution to the overall costs. The correct way to model the change in cash balances is to deduct the previous’ year cash balances from the current’s year cash balances:

$$\Delta CB_{YearX} = AP_{YearX} - AP_{YearX-1}$$

$$\Delta CB_{2004} = 1,922,501 \text{ Rand}_{2004}/year = 5,977,699 - 4,055,198$$

5.13 Projected Income Tax Statement

An income tax statement is the first set of results of the project evaluation. It statement combines various technical, financial and market data into a single statement of the project's financial performance. This statement is needed to estimate the project's annual tax liability, if any.

The projected income tax statement of the feed plant is presented in Table 12. While it follows the standard format of an income tax statement, a few issues should be discussed about modeling this statement.

Revenues: The revenues items all come from the sales of the different feed types, and their values are taken directly from the Tale of Production and Feed Sales. Note that there are no accounts receivable or the changes in accounts receivable here. All the figures are expressed in nominal terms.

Cost of Goods Sold and Gross Margin: The cost of goods sold item was obtained from the “value of consumed inputs” in the Schedule of Feed Ingredients Inventory. The gross margin shows the difference between the total sales and cost of goods sold, or what is left for the producer to cover all the current operating costs and to amortize the initial investment costs.

Expenses: All the expense items, with an exception of the depreciation expense, are taken from the Schedule of Operating Expenses. All the figures are annual nominal expenses. The depreciation expense is linked to the “grant adjusted annual depreciation expense” line from the Tax Depreciation Schedule.

Income Before Interest and Taxes: This line is calculated by subtracting all direct and indirect operating costs from the total revenues.

Income Before Taxes: This line is calculated by subtracting the interest expense from the income before interest and taxes. Note that only the interest portion of the annual nominal repayment is eligible to be deducted as an expense.

Cumulative Losses: In many countries, including South Africa, the tax code permits a deduction of the corporate income losses from the previous years. If a business makes losses for a few years in a row, their cumulated losses can be subtracted from the current taxable income to arrive at the final corporate income tax for the current year. In South Africa, such losses can be formally carried over indefinitely, since no restriction is set for the number of years to limit the

carry-over of losses. Thus, this line should show the total amount of the income losses accumulated from the previous years. The cumulative losses can be zero, but usually they will have a negative sign, the formula used here to do this task is:

$$\text{Cumulative Losses}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) = \text{MIN}(0, \text{Income Before Taxes}_{\text{YearX}} + \text{Cumulative Losses}_{\text{YearX-1}})$$

$$\text{Cumulative Losses}_{2004} = \text{MIN}(0, 13,852,072 + [-6,192,673]) = 0 \text{ Rand}_{2004}/\text{year}$$

What the “MIN” function does here is the selection of the minimum value of either zero, representing no loss, or summation of the current year’s income before tax and the previous year cumulative losses. If this year income before taxes is negative, then this loss will be added to the past accumulated losses, however if the current income before taxes is positive then it will reduce the amount of accumulated losses. In the example above, the cumulative losses in year 2002 totaled 6,192,673 Rand while the income before tax is 13,852,072 Rand, which imply that the current year’s income is sufficient to cover the amount of the past accumulated losses. At the same time, the current income before taxes can be reduced by the amount of the accumulated losses for tax purposes.

Taxable Income: This line is needed to show the amount of the taxable income, which can be defined as the difference between the current income before taxes and the cumulative tax less carry forward. The taxable income can be either positive or zero and the formula to model it takes the form of:

$$\text{Taxable Income}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) = \text{MAX}(0, \text{Income Before Taxes}_{\text{YearX}} + \text{Cumulative Losses}_{\text{YearX-1}})$$

$$\text{Taxable Income}_{2004} = \text{MAX}(0, 13,852,072 + [-6,192,673]) = 7,659,673 \text{ Rand}_{2004}/\text{year}$$

The cumulative losses from year 2003 are not zero and then the current 2004-year income before taxes is reduced by the amount of the past cumulative losses. At the same time, if the income before taxes was negative, then the function will return zero as the amount of taxable income.

Income Tax: The amount of income tax is based on the current taxable income before taxes and the corporate income tax rate. However, the tax law of South Africa envisages a 4-year tax-holiday incentive for start-up business like the feed plant. Therefore, the “IF” function is used to model the income tax calculation:

$$\text{Income Tax}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) = \text{IF}(\text{YearX} > (2002 + \text{Tax Holiday}), \text{Taxable Income}_{\text{YearX}} * \text{Tax Rate}, 0)$$

$$\text{Income Tax}_{2004} = \text{IF}(2004 > (2002 + 4), 7,659,673 * 30\%, 0) = 0 \text{ Rand}_{2004}/\text{year}$$

Because the current 2004 year is still in the tax holiday period, no income tax is computed. The formula automatically picks up any changes in the length of the tax holiday when the

parameter is adjusted in the Table of Parameters. If there are any other corporate taxes, they should also be deducted at this point.

Income / Loss After Taxes: This is the bottom line of the income statement, indicating if the enterprise is making or loosing money in a particular year from the point of view of tax authorities. It is computed by deducting the taxes from the taxable income. The project's income after taxes for year 2004 is estimated as 7,659,673 Rand₂₀₀₄/year.

While the income statement gives a good idea about financial performance of the project, it does not answer the question if the project is financially and economically feasible, and whether the owners, financial institutions and government should be involved in it. A further analysis needed, and the consequent sections look into the feasibility issue from different perspectives.

5.14 Banker's Point of View

Following the construction of the projected income tax statement through time and estimation of income tax liability, a projected cash flow statement from "banker's point of view" is modeled, based on the computed tables and schedules. The banker's or total investment's point of view is first evaluation perspective, from which a typical project should be analyzed. Conceptually, this perspective is needed to look at the project being without any external finance, like the project is being run from the equity of the owners. The reason why it is important in order to look at the project from this angle is that this really shows the strength of the project to repay its loans, if such are taken.

5.14.1 Projected Cashflow Statement from Banker's Point of View

The banker's point of view is relevant for a person/institution, who is in a position to take part in the debt financing of the enterprise. Before a banker approves any loan to be disbursed to the project, he wants to make sure that the project is capable of repaying the loan in full and in a timely manner.

Thus, the financial assessment of a project from the banker's point of view is based on the cashflow projections, excluding any items related to commercial bank loans, i.e. loan receipts and loan repayments. A typical nominal cash flow statement for the banker's point of view is presented in Table 13. All figures are projected in nominal values.

Any cash flow statement consists of two parts: revenues and expenditures. At the very bottom, the net cash flow is calculated, which is the difference between the annual revenues and expenditures. What the figures of the net cash flow tell the analyst is whether a sufficient net cashflow is available to service the debt financing undertaken by the project and to ensure a return to the owners of the equity participation in the enterprise. While such a brief evaluation is very illustrative and useful, a further analysis is needed to look into the relationship between the projected net cash flow and proposed loan repayments. This is the core relationship to the banker's point of view, and it will be discussed in Section 5.14.2.

Revenues

Referring to Table 13, the revenues consist of the feed sales, change in the accounts receivable, change in the feed inventory, liquidation values of the assets and the grant. The annual nominal projections of feed sales by type are taken directly from the Production and Feed Sales Schedule. The change in accounts receivable is linked to the computed values in the Working Capital Schedule, and the change in feed inventory is referred back to the Feed Inventory Schedule. The change in accounts receivable as well as the change in feed inventory in year 2003 are negative figures, which can be explained by the fact that both the amount of the accounts receivable and the stock of feed inventory are on rise in 2003, which means a negative cash inflow for the enterprise.

The residuals values, in nominal terms, are taken from the Economic Depreciation Schedule. Note that the only year when these residual values appear in the cashflows is the last 2013 year, at the time "liquidation" of the business. The last item of the revenue side is the grant disbursements in year 2002 and 2003. The total revenues line summarizes all the annual revenues, and its projected amount of cash inflows during year 2003 is 197,169,549 Rand₂₀₀₃.

Expenditures

The expenditure side of this cashflow statement is lengthier, but it can be grouped into four sections: investment costs, operating costs, working capital items and income tax. The investment costs are all expressed in nominal domestic currency, and they are actually linked back to the summary of the investment costs. The whole burden of capital investment, amounting to 88,652,055 Rand₂₀₀₂, is to materialize in year 2002, and there are no other capital expenditures in the consequent years. Note that the annual depreciation of the assets is already captured in the liquidation values, which are the difference between the initial value of the plant assets and

accumulated depreciation. Therefore, no annual depreciation expense is included into cash flows, unlike the Income Tax Statement.

The operating costs can be further sub-divided into direct operating costs, and indirect operating costs. The direct operating costs include feed ingredients, labor, electricity, water, transportation and storage, and equipment mechanic service. The annual nominal cost of feed ingredients is taken from the “value of purchased inputs” from the Feed Ingredients Inventory Schedule. The projections of all the other operating costs come from the Schedule of Operating Expenses. The total operating costs in year 2003 amount to 244,127,878 Rand₂₀₀₃.

The changes in accounts payable and cash balances are taken from the Working Capital Schedule. Their signs in year 2003 conform to the expectation of the change in accounts payable being negative, which reduces the costs, and of the change in cash balances being positive, which does increase the costs.

The income tax amount is linked to the amount of income tax paid in the Income Tax Statement. The total expenditures line sums up all the costs, and its projected amount in year is 244,283,867 Rand₂₀₀₃. This makes the estimated net cash flow in year 2004 to be –47,114,318 Rand₂₀₀₃, which is the difference between the total revenues and total expenses.

Nominal versus Real Cash Flows

The constructed nominal cash flow statement for banker’s point of view does reflect the cash flows associated with the feed project; however, the analysis can not be based on the nominal figures since they are distorted from the real values by inflation. The inflation impact must be removed from the cashflows to enable the analyst to see the flows of real resources. At the same time, the real cashflows, i.e. nominated in the fixed prices, will serve as a base for the economic analysis later.

Such a conversion from the current prices to the real, year-2002, values can be made by dividing all the figures of the nominal cash flow statement by the corresponding annual domestic price index. Because the domestic price index incorporates all the inflation rates in the preceding years, the resulting real value is expressed in the prices of the year-zero:

$$\text{Cashflow Item}^{\text{Real}}_{\text{YearX}} (\text{Rand}_{2002}/\text{year}) = \text{Cashflow Item}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) / I^{\text{D}}_{\text{YearX}}$$

$$\text{Transportation}^{\text{Real}}_{2004} = 1,179,780 / 1.12 = 1,050,000 \text{ Rand}_{2002}/\text{year}$$

This conversion should be performed for all cashflow items, year by year, in order to derive the real, year-2002 valued, cash flow statement for banker’s point of view. Table 14 shows the

projected real cash flow statement from the banker's point of view. Note that the same order of items is maintained in the real statement, as was done in the nominal. Having obtained the real cashflow statement, enables the analyst to step up with further inquiry into the financial performance of the feed project.

5.14.2 Debt Service Ratios as an Evaluation Criteria

Neither NPV nor IRR are calculated for the banker's point of view. The main criteria in the assessment of the project's ability to repay its debts is the annual debt service capacity ratio (ADSCR), which simply compares the amount of current net cash flow to the current debt obligations. If the net cash flow amount is greater than the debt repayment then the project can be said capable of repaying its debt obligations on a year-to-year basis. Table III below shows the real Projected Cash Flow Statement from the Owner's Point of View as well as the calculation of the ADSCR and DSCR ratios.

ADSCR

Usually, the calculations of debt service ratios take place after the real projections from the banker's point of view, and Table 14 shows the computed debt ratios for the feed project. The ADSCR ratios are calculated only for the periods in which repayments are made and "annual debt repayment" includes both annual interest and principal repayment. The formula used for calculation of ADSCR is:

$$ADSCR_{YearX} = \text{Annual Net Cash Flow before Financing}^{\text{Real}}_{YearX} / \text{Annual Debt Repayment}^{\text{Real}}_{YearX}$$

The annual net cash flow before financing is the net cash flow of the real cash flow statement from the banker's point of view, and the annual real debt repayment is taken from the Loan Schedule. A negative ADSCR ratio implies that the project has a negative cashflow in a certain year, and the inflows are not even enough to cover all the cash outlays. A positive ratio less than unity means that the project is able to cover its expenditures, but there is not enough cash to make the debt repayment in full to the bank. A ratio of unity infers that the project is just breaking even in terms of covering its expenses and repaying the debt obligations but there is no cash available to provide a return to equity. A positive ADSCR well above one implies that there is enough cash generated by the business to repay both expenses and debt installments and give some return to the equity owner(s).

An “IF” function of MS-Excel is used to compute the ADSCR, in order for it to be flexible with the start and end dates of loan repayment. What the function does is that it shows a sign “-” in the years when there is no loan repayments made, instead of showing a division by zero error:

$$\text{ADSCR}_{\text{YearX}} = \text{IF}(\text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}} = 0, \text{“-“}, \text{Annual Net Cash Flow before Financing}^{\text{Real}}_{\text{YearX}} / \text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}})$$

$$\text{ADSCR}_{2003} = \text{IF}(0 = 0, \text{“-“}, -44,447,470 / 0) = \text{“-“}$$

$$\text{ADSCR}_{2004} = \text{IF}(8,185,353 \neq 0, \text{“-“}, 6,293,606 / 8,185,353) = 0.77$$

$$\text{ADSCR}_{2005} = \text{IF}(8,185,353 \neq 0, \text{“-“}, 17,714,074 / 7,722,031) = 2.29$$

This is a usual cash profile of a commercial project to have an increasing ADSCR during the first years of operation. As the project successfully establishes itself on the market and achieves its capacity, the cash revenues stabilize and provide a sufficient amount of cash for both the financing bank and the owner(s) of the business.

DSCR

Another related measure of project’s financial strength is the Debt Service Capacity Ratio (DSCR), which is simply the accumulated annual debt service capacity ratio. The DSCR is calculated only for periods in which debt repayments take place, and formula has the form of:

$$\text{DSCR}_{\text{YearX}} = \text{PV of Annual Net Cash Flows}^{\text{Real}}_{\text{YearX}} / \text{PV of Annual Debt Repayment}^{\text{Real}}_{\text{YearX}}$$

This ratio summarizes the project’s ability to repay its debt obligations over the remaining years of the debt service, not for just a single year. While the ADSCR looks on this project strength on a year-to-year basis, the DSCR ratio approaches the task from a wider angle and takes both remaining net cashflow and remaining debt repayments into consideration. The debt service capacity ratio is useful to examine how to obtain sufficient financial resources during questionable financial periods, in which the annual capability of servicing the debt is doubtful. As a rule of thumb, a DSCR ratios of 1.5 to 2.0 magnitude signify an “acceptable” coverage of the debt obligations by the project and ratios less than that indicate either a poor financial design or/and a bad business enterprise. In fact, such ratios are of rather subjective nature and it depends on the industry standards and individual risk preferences what is really an “acceptable” ratio. Typically, a bank has its own schedule of acceptable ratios for the different industries and project sizes. In a more complete discussion of the use of this measure see Chapter 3 of the *Manual (2003)*.

Net Cash Flow for Debt Repayment Function: Modeling the actual ratios can be complex sometimes, and may involve several functions. The feed project DSCR computations need a few extra lines in order to compute the DSCR ratios. The net cash flow for debt repayment function (NCF for DRF) is one which is needed to show the amount of the net cash flow in a particular year when a debt repayment is made in that year, and to show zero otherwise:

$$\text{NCF for DRF}_{\text{YearX}} = \text{IF}(\text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}} = 0, 0, \text{Annual Net Cash Flow before Financing}^{\text{Real}}_{\text{YearX}})$$

$$\text{NCF for DRF}_{2003} = \text{IF}(0 = 0, 0, -44,447,470) = 0 \text{ Rand}_{2002}$$

$$\text{NCF for DRF}_{2004} = \text{IF}(8,185,353 \neq 0, 0, 6,293,606) = 6,293,606 \text{ Rand}_{2002}$$

Present Value of Net Cash Flow: This line is also artificially created in order to compute the present value of the annual net cash flow in the remaining years of the repayment period. Because it is based on the computed above net cash flow for debt repayment function, instead of the original net cash flow line, this PV includes only the years of actual debt repayment. The relevant discount rate for such present value is the real interest rate (r), which will be also used for discounting the annual real debt repayments. The function used here is the “NPV” function of MS-Excel:

$$\text{PV of NCF}_{\text{YearX}} = \text{NPV}(r, \text{NCF for DRF}_{\text{YearX}+1}:\text{NCF for DRF}_{2013}) + \text{NCF for DRF}_{\text{YearX}}$$

Note that the present value is estimated for each year, treating that year as the base year of discounting. Therefore, the function excludes that year’s value from discounting NPV function, simply because that value is already in its “real” form. For instance, here are examples of this estimation for year 2003 and 2004:

$$\text{PV of NCF}_{2003} = \text{NPV}(r, \text{NCF for DRF}_{2004}:\text{NCF for DRF}_{2013}) + \text{NCF for DRF}_{2003}$$

$$\text{PV of NCF}_{2003} = \text{NPV}(8.5\%, \text{NCF for DRF}_{2004}:\text{NCF for DRF}_{2013}) + 0 = 68,929,060 \text{ Rand}_{2002}$$

$$\text{PV of NCF}_{2004} = \text{NPV}(r, \text{NCF for DRF}_{2005}:\text{NCF for DRF}_{2013}) + \text{NCF for DRF}_{2004}$$

$$\text{PV of NCF}_{2004} = \text{NPV}(8.5\%, \text{NCF for DRF}_{2005}:\text{NCF for DRF}_{2013}) + 6,293,606 = 74,788,030 \text{ Rand}_{2002}$$

Present Value of Debt Repayments: This line is needed to show the present value of the repayment in the all remaining years of debt service. The same “NPV” function is used to compute the present value of debt repayments (PV of DR):

$$\text{PV of DR}_{\text{YearX}} =$$

$$= \text{NPV}(r, \text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}+1}:\text{Annual Debt Repayment}^{\text{Real}}_{2013}) + \text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}}$$

$$\text{PV of DR}_{2003} =$$

$$= \text{NPV}(8.5\%, \text{Annual Debt Repayment}^{\text{Real}}_{2004}:\text{Annual Debt Repayment}^{\text{Real}}_{2013}) + 0 = 29,078,001 \text{ Rand}_{2002}$$

$$\begin{aligned} & \text{PV of DR}_{2004} = \\ & = \text{NPV}(8.5\%, \text{Annual Debt Repayment}^{\text{Real}}_{2005} : \text{Annual Debt Repayment}^{\text{Real}}_{2013}) + 8,185,353 = 31,549,631 \text{ Rand}_{2002} \end{aligned}$$

DSCR: Finally, the ratio itself can be estimated with the help of the previous formulas. The definition of the debt service capacity ratio defined as the present value of the annual net cash flows divided over the present value of the annual debt repayments. In order to avoid seeing an error message when there is no debt repayment, the “IF” function is used once again:

$$\text{DSCR}_{\text{YearX}} = \text{IF}(\text{Annual Debt Repayment}^{\text{Real}}_{\text{YearX}} = 0, \text{“-“}, \text{PV of NCF}^{\text{Real}}_{\text{YearX}} / \text{PV of DR}^{\text{Real}}_{\text{YearX}})$$

$$\text{DSCR}_{2003} = \text{IF}(0 = 0, \text{“-“}, 68,929,060 / 29,078,001) = 2.37$$

$$\text{DSCR}_{2004} = \text{IF}(8,185,353 \neq 0, \text{“-“}, 74,788,030 / 31,549,631) = 2.93$$

Table III. Projected Cash Flow Statement: Banker's Point of View, Rand, Real₂₀₀₂.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
REVENUES									
Feed Sales	0	205,032,821	305,457,060	388,307,058	391,654,532	391,654,532	391,654,532	391,654,532	391,654,532
Total Sales	0	205,032,821	305,457,060	388,307,058	391,654,532	391,654,532	391,654,532	391,654,532	391,654,532
Change in A/R	0	-7,885,878	-4,308,841	-3,851,539	-974,120	-852,659	-852,659	-852,659	-852,659
Change in Feed Inventory	0	-12,553,030	126,320	-4,010,654	-852,659	-852,659	-852,659	-852,659	-852,659
Liquidation Values	0	0	0	0	0	0	0	0	0
Grant	1,500,000	1,415,094	0	0	0	0	0	0	0
TOTAL REVENUES	1,500,000	186,009,008	301,274,539	380,444,865	389,827,754	389,949,215	389,949,215	389,949,215	389,949,215
EXPENDITURES									
INVESTMENT COSTS									
Land	1,200,000	0	0	0	0	0	0	0	0
Construction	37,807,744	0	0	0	0	0	0	0	0
Vehicles	448,000	0	0	0	0	0	0	0	0
TOTAL INVESTMENT COSTS	88,652,055	0	0	0	0	0	0	0	0
OPERATING COSTS									
DIRECT COSTS									
Feed Ingredients	15,675,000	216,315,000	275,880,000	338,580,000	338,580,000	338,580,000	338,580,000	338,580,000	338,580,000
Labor	0	1,698,048	1,822,893	1,948,944	1,958,689	1,968,482	1,978,325	1,988,216	1,998,158
Electricity	0	561,045	778,834	998,549	1,002,996	1,007,466	1,011,958	1,016,472	1,021,009
Water	0	240,643	340,979	443,297	447,730	452,208	456,730	461,297	465,910
Equipment Mechanic Service	0	594,584	832,417	1,070,251	1,070,251	1,070,251	1,070,251	1,070,251	1,070,251
Transportation and Storage	0	1,000,000	1,400,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
TOTAL DIRECT OPERATING COSTS	15,675,000	220,409,319	281,055,123	344,841,041	344,859,666	344,878,406	344,897,263	344,916,236	344,935,327
INDIRECT OPERATING COSTS									
Administration									
Office Accommodation	0	600,000	840,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000
Telecommunication	0	300,000	420,000	540,000	540,000	540,000	540,000	540,000	540,000
Advertising	0	5,000,000	7,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000
Audit and Accounting Services	0	2,500,000	3,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000
Business Travel	0	500,000	700,000	900,000	900,000	900,000	900,000	900,000	900,000
Transportation	0	750,000	1,050,000	1,350,000	1,350,000	1,350,000	1,350,000	1,350,000	1,350,000
Office and Transportation Services	0	250,000	350,000	450,000	450,000	450,000	450,000	450,000	450,000
TOTAL INDIRECT OPERATING COSTS	0	9,900,000	13,860,000	17,820,000	17,820,000	17,820,000	17,820,000	17,820,000	17,820,000
TOTAL OPERATING COSTS	15,675,000	230,309,319	294,915,123	362,661,041	362,679,666	362,698,406	362,717,263	362,736,236	362,755,327
Change in A/P	0	-3,678,982	-1,645,239	-1,743,739	-372,252	-372,275	-372,298	-372,320	-372,343
Change in C/B	0	3,826,141	1,711,049	1,813,489	387,143	387,166	387,189	387,213	387,237
Corporate Income Tax	0	0	0	0	0	6,844,729	8,985,780	9,256,569	9,272,191
TOTAL EXPENDITURES	104,327,055	230,456,478	294,980,933	362,730,791	362,694,556	369,558,027	371,717,935	372,007,698	372,042,412
NET CASH FLOW	-102,827,055	-44,447,470	6,293,606	17,714,074	27,133,197	20,391,188	18,231,280	17,941,517	17,906,803
ADSCR									
	-	-	0.77	2.29	3.72	2.97	2.81	-	-
DSCR									
	-	-	2.37	2.93	3.21	2.89	2.81	-	-

5.15 Owner's Point of View

The next logical step in the evaluation is to look at the project from the owner's perspective, as it would be relevant to the project owner(s). This point of view is distinctly different from the other evaluation perspectives by inclusion of all loan and similar external finance items, as well as the grant receipts. The idea is to assess the financial performance of the project with all the supplementary external financing so that the owner could make his mind of whether this business is worth investing into.

5.15.1 Net Present Value

The net present value (NPV) is an algebraic summation of the present values of the project's annual net cash flows over its lifetime. This is the main evaluation criteria to help the owner assess the project's net worth, compared with the owner's alternative investment opportunity. Because a typical investor has a variety of choices to invest the capital in, the investment into this particular project must be justified by having a return higher than on the other alternatives, given the riskiness of the proposed projects is the same. In other words, the investor usually has a benchmark return-on-investment rate (ROI), which is the minimum acceptable return. Such a benchmark is a subjective measure and it really depends on the availability and returns of the other investment opportunities as well as on the owner's risk preferences. Whatever the threshold rate is chosen, it will be used to discount all the annual net cashflows to a single value in order to see if this net present value is more or equal to zero. If the project's net present value (NPV), discounted by the chosen ROI rate, is zero then this implies that the project just breaks even and does not make either profit or loss. A positive NPV implies that the project is capable of generating the minimum required ROI as well as some additional profits. A negative NPV signifies the failure of the project to ensure the minimum ROI, and the owner will, most probably, lose money in this business under the given circumstances.

Table 15 presents the nominal Projected Cashflow Statement from the "Owner's Point of View". Note that the order of the items is the same as in the cashflow from the owner's point of view with an exception that the annual nominal loan receipts are included on the revenue side and annual nominal debt repayment is added to the expenditures. While almost all the cash flow items are linked directly to the nominal cashflow from the owner's point of view, only the loan receipts

and debt repayments are taken directly from the loan schedule. The resulting cashflow shows the projected cash movements, valued at the current nominal prices.

Because the nominal cashflows are distorted by inflation, and it is not possible to discount them straight away and they have to be deflated to the base-year price level. The same formula used here as for the banker's point of view:

$$\text{Cashflow Item}^{\text{Real}}_{\text{YearX}} (\text{Rand}_{2002}/\text{year}) = \text{Cashflow Item}^{\text{Nominal}}_{\text{YearX}} (\text{Rand}_{\text{YearX}}/\text{year}) / I^{\text{D}}_{\text{YearX}}$$

The resulting real cashflows are shown in Table 16. They possess the property of being expressed in the same price level of year 2002 and it is now possible to discount them and find the net present value for the owner's point of view. The "NPV" formula is based on the real cashflow, and the relevant discount rate is the real return-on-investment rate:

$$\text{NPV}_{\text{Owner}}(\text{Rand}_{2002}) = \text{NPV}(\text{ROI}^{\text{Real}}, \text{Annual NCF}^{\text{Real}}_{2003} : \text{Annual NCF}^{\text{Real}}_{2013}) + \text{Annual NCF}^{\text{Real}}_{2002}$$

Once again, notice that because the net cash flow of year 2002 is already in its real equivalent, it should not be included into the discounting bracket of the "NPV" formula and should be simply added at the end of the formula. There is only a single NPV to be computed, placed in the year-zero of the project. This net present value really summarizes all the cashflows of the feed project.

There are two approaches of using the NPV in the evaluation of a project. If all the parameters of the project are known and can be reliably projected in the future, then it is easy to compute a NPV, which is a performance indicator of the project built under the stated parameters. If any of the project's parameters are to change, the computed NPV will also be altered. With any given set of parameters, the project will have its own NPV as a summary measure of its financial performance. The computed NPV will tell the analyst whether the project is to profit, make losses or just break even. The use of this approach is to evaluate the financial feasibility of the project.

Another approach to use NPV in the analysis of the project's results is to select the value of the most vital variable(s) so that the NPV is set to zero, meaning that the project just breaks even. What this approach achieves is that it allows the analyst to find the critical level of the parameter(s) at which the project just breaks even. Then, the break-even value of the critical variable(s) is compared with the actual observations on these parameters and conclusions can be drawn if the project's revenues are realistically close to cover its costs.

In regard to the feed plant, it seems more appropriate to apply the second method. The logic behind this is that the actual data does not contain enough information about what will be the project's cost of milling, or how economically the plant can process the raw materials. The

question is really over the economies of scale, if any, possessed by this feed plant. If the plant is able to lower its cost of milling below the level of the other feed manufacturers, other things being constant, then the project can derive more profit from the operations. From this perspective, the size of the milling fee is really the key to the survival of the project because the other manufacturers face the same costs of feed ingredients. In this situation, the approach of setting the break-even NPV by changing the milling fee addresses this issue and allows to see if the computed break-even milling fee is more or less competitive with the existing producers.

Thus, the computed NPV of the owner's point of view is set to zero, and this result is achieved by changing the size of the milling fee in the Table of Parameters. The mechanical iteration and selection of the break-even milling fee value is left to the MS-Excel function "Goal Seek", which finds a specific value for a cell (NPV) by adjusting the value of one other cell (Milling Fee). When goal seeking, MS-Excel varies the milling fee value in the specified cell until the financial model of the feed plant returns the desired outcome of the NPV being zero.

The break-even value of the milling fee is 258.8 Rand₂₀₀₂/ton. What this means is that with the given investment and operating costs, cost of capital, inflation level, the difference between the average feed ingredients costs and average feed price must be, at least, 258.8 Rand₂₀₀₂/ton for the project to survive. Any value below the benchmark milling fee will result in the NPV being negative, which signifies an unfeasible project. At the same time, if the feed market prices allow the plant to charge a higher price than the 258.8 Rand₂₀₀₂/ton fee then the project's NPV will rise, making it more attractive for investors.

The break-even value of the milling fee also tells about the technical efficiency of the plant, as compared to other feed manufacturers. From an interview with an AFMA senior associate an estimate of the typical milling margin was obtained, and the figure cited was 200 Rand₂₀₀₂/ton, which is the difference between the cost of raw materials and the price of feed. The manufacturer must fit into this tight margin with all its costs in order to stay competitive. The derived break-even milling fee for the proposed plant seems to be above the stated AFMA average margin, and this is a worrisome point.

However, looking at the resulting break-even feed prices from the project reveals that they are a little bit lower than the typical feed prices in Limpopo Province. Because the feed prices are expressed as a direct function of the feed ingredients cost and milling fee, the project seems to be in the range of the average prices and it may have some room for price reductions, if needed. Thus, the evidence here is not conclusive about whether the plant technical efficiency is significantly

different from the industrial average. For the purposes of further analysis, the value of the NPV from the owner's point of view is set to zero. Table IV below shows the real Projected Cash Flow Statement from the Owner's Point of View.

5.15.2 Internal Rate of Return

The internal rate of return can be defined as the discount rate that sets NPV to zero. However, this measure is not the main project evaluation criterion for the feed plant. Chapter 3 in the *Manual (2003)* lists a number of reasons why the IRR fails to serve as a project evaluation criterion. The most severe drawbacks of IRR are:

- IRR may not be unique, multiple IRR can be found, or not even a single IRR may exist,
- Wrong ordering of projects of different scales,
- IRR favors projects with shorter lives,
- IRR can be misleading for projects with different timing.

In other words, the IRR is not taken here as the main evaluation criterion and its computation will serve only an illustrative function. Because the results can be deceptive, the project decisions should not be based on the IRR.

The formula used to calculate the IRR is based on the real annual net cashflow of the project from the owner's point of view, and it has form of:

$$IRR_{\text{Owner}}(\text{Rand}_{2002}) = IRR(\text{Annual NCF}^{\text{Real}}_{2002} : \text{Annual NCF}^{\text{Real}}_{2013})$$

What is true about the IRR is that its value is equal to the discount rate when the NPV is set to zero. This is the definition of the IRR, which makes this identity to hold true, and it is not a coincidence that the computed IRR is equal to 15.0%. The IRR will be useful as an indicator of the relative impact of the variable in the sensitivity analysis, where the changes in various project parameters will be tested on their impact on the project's NPV, IRR and debt service capacity ratios.

Table IV. Projected Cash Flow Statement: Owner's Point of View, Rand, Real₂₀₀₂.

YEAR:	2002	2003	2004	2005	2006	2007	2008	2009	2010
REVENUES									
Feed Sales	0	205,032,821	305,457,060	388,307,058	391,654,532	391,654,532	391,654,532	391,654,532	391,654,532
Total Sales	0	205,032,821	305,457,060	388,307,058	391,654,532	391,654,532	391,654,532	391,654,532	391,654,532
Change in A/R	0	-7,885,878	-4,308,841	-3,851,539	-974,120	-852,659	-852,659	-852,659	-852,659
Change in Feed Inventory	0	-12,553,030	126,320	-4,010,654	-852,659	-852,659	-852,659	-852,659	-852,659
Liquidation Values	0	0	0	0	0	0	0	0	0
Grant	1,500,000	1,415,094	0	0	0	0	0	0	0
Loan Receipts	26,800,001	0	0	0	0	0	0	0	0
TOTAL REVENUES	28,300,001	186,009,008	301,274,539	380,444,865	389,827,754	389,949,215	389,949,215	389,949,215	389,949,215
EXPENDITURES									
INVESTMENT COSTS									
Land	1,200,000	0	0	0	0	0	0	0	0
Construction	37,807,744	0	0	0	0	0	0	0	0
Equipment	49,196,311	0	0	0	0	0	0	0	0
Vehicles	448,000	0	0	0	0	0	0	0	0
TOTAL INVESTMENT COSTS	88,652,055	0	0	0	0	0	0	0	0
OPERATING COSTS									
DIRECT COSTS									
Feed Ingredients	15,675,000	216,315,000	275,880,000	338,580,000	338,580,000	338,580,000	338,580,000	338,580,000	338,580,000
Labor	0	1,698,048	1,822,893	1,948,944	1,958,689	1,968,482	1,978,325	1,988,216	1,998,158
Electricity	0	561,045	778,834	998,549	1,002,996	1,007,466	1,011,958	1,016,472	1,021,009
Water	0	240,643	340,979	443,297	447,730	452,208	456,730	461,297	465,910
Equipment Mechanic Service	0	594,584	832,417	1,070,251	1,070,251	1,070,251	1,070,251	1,070,251	1,070,251
Transportation and Storage	0	1,000,000	1,400,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
TOTAL DIRECT OPERATING COSTS	15,675,000	220,409,319	281,055,123	344,841,041	344,859,666	344,878,406	344,897,263	344,916,236	344,935,327
INDIRECT OPERATING COSTS									
Administration									
Office Accommodation	0	600,000	840,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000	1,080,000
Telecommunication	0	300,000	420,000	540,000	540,000	540,000	540,000	540,000	540,000
Advertising	0	5,000,000	7,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000
Audit and Accounting Services	0	2,500,000	3,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000
Business Travel	0	500,000	700,000	900,000	900,000	900,000	900,000	900,000	900,000
Transportation	0	750,000	1,050,000	1,350,000	1,350,000	1,350,000	1,350,000	1,350,000	1,350,000
Office and Transportation Services	0	250,000	350,000	450,000	450,000	450,000	450,000	450,000	450,000
TOTAL INDIRECT OPERATING COSTS	0	9,900,000	13,860,000	17,820,000	17,820,000	17,820,000	17,820,000	17,820,000	17,820,000
TOTAL OPERATING COSTS	15,675,000	230,309,319	294,915,123	362,661,041	362,679,666	362,698,406	362,717,263	362,736,236	362,755,327
Change in A/P	0	-3,678,982	-1,645,239	-1,743,739	-372,252	-372,275	-372,298	-372,320	-372,343
Change in C/B	0	3,826,141	1,711,049	1,813,489	387,143	387,166	387,189	387,213	387,237
Loan Repayments	0	0	8,185,353	7,722,031	7,284,935	6,872,580	6,483,566	0	0
Corporate Income Tax	0	0	0	0	0	6,844,729	8,985,780	9,256,569	9,272,191
TOTAL EXPENDITURES	104,327,055	230,456,478	303,166,285	370,452,821	369,979,491	376,430,607	378,201,500	372,007,698	372,042,412
NET CASH FLOW	-76,027,054	-44,447,470	-1,891,746	9,992,043	19,848,263	13,518,608	11,747,715	17,941,517	17,906,803

NPV at 10.0%	0.0
IRR	10.00%

5.16 Financial Sensitivity Analysis

The purpose of the sensitivity analysis in project evaluation is to test the responsiveness of the project's outcomes to changes in the parameters of the model such as prices, quantities, growth rates, elasticities and so on. The beauty of the sensitivity analysis is in its ability to reveal the major hidden flaws and omissions in project financial design, and to enable the analyst to realistically simulate possible real-life conditions into the financial model. The idea is to take a single parameter and test the model over a range of the possible values of the selected parameter, so that the model recalculates its final outcomes with each value of the parameter. In other words, the spreadsheet computes a set of outcomes corresponding to the chosen range of values of the parameter in question.

Technically, the MS-Excel spreadsheet program does not require the user to make multiple copies of the same model in order to test the sensitivity of the model to changes in a parameter. Instead, a special function called "Table" is designed to help the analyst to handle this task. This function tabulates the defined projects outcomes under the various values of the tested parameter.

For the purpose of financial sensitivity analysis, the analyst should include the model's outcomes from the banker's and owner's points of view, which are typically the debt service ratios for the banker's perspective and the net present value for the owner's perspective. Thus, for almost all sensitivity tests made here, the following project's performance criteria are considered: NPV and IRR for owner's point of view, ADSCR ratios for the first three years of loan repayment (2004, 2005 and 2006), and DSCR for the whole period of loan repayment (2004).

Note, that the sensitivity analysis can test only one or, at most, two parameters at a time, assuming that all other parameters remain constant. Thus, the only change in the project's model comes about from the tested parameter, and the model's sensitivity measures only the specified parameter(s). This allows the analyst to see the relative importance of each parameter to the project's performance. The parameters with the highest variability are indeed important while some parameters that do not have a substantial impact on the project, are somewhat less crucial to the project.

To make the comparison across the different tested parameters easier, the analyst may use a scale of sensitivity, labeling the parameter as "high", "medium", "low" and "none" depending on the responsiveness of the project's outcomes to a change in the parameter. Such a scale is a

subjective assessment of sensitivity and it is the task of analyst to define the exact boundaries of these benchmarks.

5.16.1 *Change in Cost of Feed Ingredients*

The feed ingredients cost is the most fluctuating variable, which changes on a daily basis and its normal range of movements can be $\pm 25\%$. Therefore, for the sensitivity test here, the change in the cost of feed ingredients has been assigned a range from -25% to $+25\%$ with increments of 5% . Table 17 shows the results of this test in a tabular form: the headline above contains the project's outcomes being the measures of the project's performance, and the first column has the tested for the change in the cost of ingredients. The first column presents the computed NPVs from owner's point of view, corresponding to each value of the parameter under the test. For instance, if the change in the cost of ingredients remain -25% throughout the project life (i.e. the feed ingredients are cheaper by 25%), then the financial net present value of the feed project from the owner's point of view would climb to 17.9 million Rand₂₀₀₂, instead of being zero as in the base case. However, if the cost of feed ingredients rises by 10% and remains such throughout the project's lifespan, then the resulting NPV would be -6.7 million Rand₂₀₀₂. The pattern that can be traced here is that a cost reduction makes the financial NPV grow, which is indeed a plausible observation. The analyst can easily check whether the sensitivity table has been modeled correctly by looking at the project's outcomes at the base case value of the parameter. In the base case, the change in cost of ingredients is zero and the corresponding NPV here must be zero too, which is true.

The second column contains the computed values of the internal rate of return resulting from the changes in the cost of feed ingredients. The same pattern of relationship between the tested parameter and IRR is observed as in the case of NPV: a cost decrease causes the IRR to rise and vice-versa. When the change in the cost of ingredients is zero (base case), the resulting IRR is equal to the discount rate of 15% , which follows from the definition of the IRR.

The annual debt service coverage ratios also improve if the cost of feed ingredients decreases, and they plunge down when the input costs rise. The ADSCR₂₀₀₄, which is the debt service ratio in the very first year of debt repayment, is the lowest among the three, and this can be explained by the fact that the plant is still operating under-capacity in this year, and as it increases its capacity utilization the ADSCRs tend to rise too. The debt service coverage ratio tested here also shows a

negative relationship with the change in the cost of feed ingredients: when the cost raises – the $DSCR_{2004}$ declines and when the cost decreases – the $DSCR_{2004}$ goes up.

Overall, the model is found to be “highly” sensitive to the tested parameter. Even a little, 5% change in the cost of feed ingredients causes the project’s NPV to stray away by more than 3.4 million Rand₂₀₀₂. Given the unpredictable nature of the feed ingredients prices, this parameter can be a good candidate for the risk analysis.

5.16.2 Change in Milling Fee

Although the milling costs are not expected to change substantially over the years, it is important to test this parameter because this is the variable, which used as a tool to set the project’s NPV to zero. A range from –25% to +25% with increments of 5% is taken for the change in the break-even milling fee. The results, shown in Table 18, tell the analyst that the financial model is “highly” sensitive to this parameter, and the change in the milling fee and project’s financial performance are positively related. A decrease in the milling fee makes the NPV to decline, but an increase in the milling fee causes the NPV to rise.

The IRR and debt service ratios follow the same relationship, and tend to improve due to an increase in the fee. Note that a 5% change in this parameter causes even a greater response by the NPV, as compared to the change in cost of ingredients. However, this parameter is not likely to change over time and it does not qualify to be included into the risk analysis.

5.16.3 Domestic Inflation Rate, 2003-2013

The assumed rate of domestic inflation for years 2003-2013 was taken as 6.0% but it is very likely that the actual inflation rate will deviate from this forecast. This sensitivity test shows the response of the project to the different average inflation rates, ranging from 0% to 10% in increment of 1%. Table 19 presents the results of this sensitivity test.

The base-case assumption of a 6.0% average inflation rate results in zero value of the NPV, and if the average inflation rate declines below 6.0% then the NPV, IRR and debt service ratios all improve, while any increase in the base-case inflation rate above 6.0% will deteriorate the project’s performance. A single percentage-point change in the average inflation rate causes a 1.4 million Rand₂₀₀₂ adjustment in the NPV, which allows us to characterize this variable as a

“highly” sensitive parameter. The unpredictable nature of annual inflation rate makes it also a candidate for the risk analysis.

5.16.4 Foreign Inflation Rate, 2003-2013

The foreign inflation rate has been used in the estimation of the foreign price index and exchange rate, and also in the computation of the project’s investment costs. The base-case inflation rate of the US dollar was assumed to be, on the average, 2.5% for years 2003-2013. This sensitivity test, results of which are presented in Table 20, is used to determine the project’s responsiveness to this parameter. A range of 0%-10%, in increments of 1%, is used for the US dollar average inflation rate.

As the tabulated results of this test show, none of the project’s outcomes responds to changes in the rate of foreign inflation. The net present value, internal rate of return, and debt service ratios remain at the same level as in the base-case calculation, implying that the model has “none” elasticity to this parameter. In other words, the project does not depend on the foreign inflation rate and there is no need for any further inquiry into this variable.

5.16.5 Disturbance to Real Exchange Rate, 2002-2013

It has been assumed that the same real exchange rate between the South African Rand and US dollar will prevail over the project life. However, the real exchange rate is exposed to various domestic and international forces causing it to deviate from its long-run trend. A sensitivity test on the disturbance to the real exchange rate was performed on the $\pm 50\%$ range of disturbance with a 10% increment, and Table 21 contains the tabulated output.

The model is “highly” sensitive to changes in the real exchange rate and the relationship between this parameter and project’s indicators is such that a positive disturbance to the real exchange rate decreases the NPV, IRR and debt ratios. This parameter is indeed a good candidate for the risk analysis.

5.16.6 Financing Method

One of the exciting features of the sensitivity analysis is its ability to test various methods to finance the project. Because a variety of sources are available to the project owners to fund the

project, a careful consideration is necessary in order to find an optimal combination of the different finance options. Sensitivity tests allow to compare the different financial designs, and to select one or another for further analysis.

For the feed project, the proposed intention of the plant management is to obtain a loan to finance up to a half of the local investment costs. The company is going to use its own equity funds to purchase the equipment and to cover the remaining local costs. A Rand-nominated loan would be drawn on commercial terms from a South African bank. The sensitivity test here looks at the financing of the project as coming either from outside as a loan or as being a part of the owner's equity contribution. A different combination of loan-equity shares are tested on their impact on the project's outcome. Table 22 displays the sensitivity analysis results.

Thus, a combination of 50% share of equity and 50% of loaned funds corresponds to the base-case and makes the NPV to break-even. If the project decides to obtain a higher share of loan finance, the NPV and IRR improve due to the fact that the cost of loan is lower as compared to the cost of equity. On the other hand, if the actual finance mix contains less than 50% loaned funds, the NPV and IRR decline.

The impact of the loan share being higher than 50% benchmark on the debt service ratios is different from the NPV and IRR effects, because a higher loan share implies lower debt service ratios, keeping all other things constant. Thus, any decision to increase the share of loan financing will reduce the debt service ratios and vice versa.

The overall responsiveness of the model to changes in this parameter can be characterized as "low". The choice of financing mix is a one-time decision for this project, and because this variable has a moderate impact on the performance a further risk analysis is not needed.

5.16.7 *Loan Real Interest Rate*

The sensitivity of the project to the real interest rate can be described as "low", following the tabulated results of such a sensitivity test in Table 23. The relationship between the real interest rate and project's performance is of a negative nature: if the real interest rate increases then the project's outcomes deteriorate. This can be explained by the fact that a higher real rate on the loan would necessary imply higher real interest repayments, causing the net cash flows to decrease.

With a modest loan share in the total investment costs, the real interest rate impact is somewhat limited and because the interest rate is typically negotiated by a contract, it is not needed to include this variable into the risk analysis.

5.16.8 *Loan Grace Period*

The duration of loan grace period can be also tested on its impact on the project. Table 24 shows the results of the test with a clearly positive relationship between the duration of grace period and the project's performance. Any postponement in the start of loan repayment makes the indicators to improve. Note that because the beginning of the loan repayment shifts the resulting debt service ratios become zeros for years 2004-06. Overall, the sensitivity of the model to this parameter is "low" and it is not eligible to be included into the risk analysis.

5.16.9 *Loan Repayment Period*

Obviously, any extended loan period should benefit the project, and Table 25 contains a proof of this expectation. All the project's indicators improve if the repayment period is prolonged by a year or more, while any reduction from the base case 5-year period would cause a higher loan payment each year and the NPV, IRR and debt service ratios will decline. The model's responsiveness to this parameter is rather "low" and it can be excluded from any further inquiry.

5.16.10 *Tax Holidays*

The existing tax regulation permits a 4-year tax holiday for the start-up businesses like the feed plant. This is an investment incentive to the project and its financial benefits are estimated in Table 26. Thus, any reduction of the tax holiday will reduce the NPV and IRR by making the project pay the corporate income tax earlier, while any extension of the tax holiday would clearly affect the NPV and IRR favorably. Note that the debt service ratios are less prone to changes in this parameter. The overall sensitivity of the model to this parameter is "high" but because the duration of tax holiday is fixed by the law, it is not needed to pursue the analysis of this variable any further.

5.16.11 Investment Cost Overrun Factor

The expected effect of this parameter is to damage the project's performance if there are any cost overruns. As Table 27 confirms, this relationship holds true for all the project's indicators and a 5% unexpected rise in the amount of investment costs will lead to a negative change in the NPV of about 1.3 million Rand₂₀₀₂.

However, the portion of the total investment costs affected by the investment cost overrun factor is limited to the local costs of construction, and it is not applicable on the equipment, land and transportation expenses. Therefore, its impact on the model is "medium" and is not of critical importance as long as the cost overruns are moderate.

5.16.12 Accounts Receivable

For a cash-based business like the feed plant, it is important to test the project's sensitivity to the average amount of accounts receivable. Table 28 presents the results of this test with a clear message to the project operator to keep the amount of AR as low as possible in order to maximize the NPV, IRR and debt service ratios. Any delay in the time taken by customers to pay in cash or any increase in the amount of AR will reduce the actual net cash flows and lead the business to lose money. The model is "highly" sensitive to this variable and it is a matter of managerial effort of keeping the AR at a minimum level.

5.16.13 Accounts Payable

In the same manner, a sensitivity test is performed for the amount of accounts payable by the enterprise, with the results shown in Table 29. Again, this parameter has a strong impact on the project's performance and the model's response is "highly" sensitive. Note that the relationship is the inverse to the AR: a delay in the cash payment makes the project better off.

5.16.14 Labor Real Wage Growth

It can be argued that the real wage growth can be a bottleneck for some businesses; however this is not a crucial factor for the feed plant, as Table 30 explains. While a higher wage growth does cause harm to the project's indicators, it does not really disturb the operations and can be safely labeled being "low" in its importance. The NPV, IRR and debt service ratios all decline as

the average annual growth rate crawls up. But because the wage increases are sticky and negotiable, i.e. contractual nature, this variable is not considered in further risk analysis.

5.16.15 Electricity Real Charge Growth

The real growth rate of electricity charges is tested in Table 31, and it is found to have a “low” impact on the model. The relationship is such that any increase in the real growth rate causes the project’s outcomes to deteriorate. Given the little impact on the model and low risk of sudden real rate adjustments, this parameter is not included into the risk analysis.

5.16.16 Composite Demand Elasticity for Meat and Change in Cost of Feed Ingredients

The financial model has been using the parameter of composite demand elasticity for meat as one of the determinants of the demand for animal feed. While the Table of Parameters assumes this elasticity for meat to be equal to -1.0 in the base case, it is necessary to test the model’s responsiveness to this parameter. Table 32 shows the result of this sensitivity test in a tabular form.

Note that because there are now two variables being tested simultaneously on their impact on the NPV, the table excludes all the other indicators. The reason why these two variables are to be tested at the same time is that the base-case change in the cost of ingredients is zero and it does not allow to see the impact of the composite demand elasticity for meat. However, when the change in the cost of ingredient is different from zero, the NPV would adjust according to the value of the demand elasticity being tested. Thus, in the top row there is a range of values of the demand elasticity for meat, starting from -3.0 to -0.5 with increments of 0.25 ; and, at the same time, the first column has a range of values for the change in the cost of ingredients from -25% to $+25\%$ in steps of 5% .

At the base-case demand elasticity of -1.0 , any change in the cost of feed ingredients causes the NPV to go into the opposite direction by about 3.9 million Rand₂₀₀₂ per each 5% step. Thus, the columns of the table tell about the model’s responsiveness to changes in the cost of ingredients. Also, if the analyst looks across the rows rather than columns of this sensitivity table then it becomes obvious that the rows show the sensitivity of the NPV to the value of the composite demand elasticity for meat at every level of the change in the cost of ingredients. Thus, if the ingredients cost change by -25% , the computed NPV at the base-case elasticity of -1.0 will

be raised to 17.9 million Rand₂₀₀₂, while if the elasticity is equal to -0.75 then the NPV would be 15.1 million Rand₂₀₀₂, and if the elasticity is equal to -1.25 then the NPV would be 20.7 million Rand₂₀₀₂. In other words, if the true market composite demand elasticity for meat is more elastic than the assumed value of -1.0 , then the resulting NPV is underestimated, but if the composite demand elasticity for meat is indeed inelastic than the project's NPV is overestimated. The financial model is, in fact, "highly" sensitive to this parameter.

5.16.17 Composite Demand Elasticity for Meat and Change in Milling Fee

Because the feed price determination mechanism is based on the both change in cost of ingredients and change in milling fee, such a sensitivity test is needed to look at the impact of the composite demand elasticity for meat on the NPV in the context of changes in the milling fee. Table 33 shows the results of this test.

Note that this table is similar in its structure to the previous table. The top row is filled with different values of the demand elasticity for meat, and the first column contains the values of the change in the milling fee. At any given change in the milling fee there is a range of NPVs resulting from the different demand elasticities. A ± 0.25 deviation from the assumed -1.0 demand elasticity causes the NPV to adjust by about 0.1 million Rand₂₀₀₂, which can be characterized as relatively "low" response.

5.16.18 Supply Elasticity of Feed by Others and Change in Cost of Feed Ingredients

Another parameter deserving a sensitivity test is the supply elasticity of feed by other producers, which was assumed to be equal to 5.0 in Section 5.2.21. The range of the values for this parameter is taken from 1.0 to 8.0 in steps of 1.0 and the results are presented in Table 34.

As expected, there is "none" relationship between the feed supply elasticity by others and the change in cost of feed ingredients, which is confirmed by the constant NPVs in the sensitivity table. In other words, any value of the feed supply elasticity by others does not affect the project's performance as long as there is no change in the cost of feed ingredients.

5.16.19 Supply Elasticity of Feed by Others and Change in Milling Fee

This test measures the responsiveness of the NPV to the feed supply elasticity by others at a certain change in the cost of ingredients. Table 35 presents the results of this sensitivity test. The base-case assumes the supply elasticity of feed by others to be equal to 5.0, and the sensitivity table shows that a unit-deviation from the assumed 5.0 elasticity would lead the NPV to adjust by about 0.3 million Rand₂₀₀₂, which is relatively “low” impact.

6. ECONOMIC ANALYSIS

The main purpose of the economic evaluation of this project is to determine the economic feasibility of such a feed production and desirability of grant support for this type of business in Limpopo Province. The framework of the analysis includes the estimation of economic costs and benefits, and comparing their net present values with the corresponding net present values from the financial analysis. The economic NPV serves as an indicator of economic viability of the project, and the estimated difference between the economic and financial NPVs, so-called externalities, is the measure of the economic impact created by the project.

The roadmap of the economic analysis typically includes a section with estimation of the economic conversion factors and modeling of the economic resource flow statement.

6.1 Scope of Economic Analysis

The economic analysis has its major objective to answer the question whether the project is economically feasible in terms of generating a net addition to the country's wealth, as measured by the economic net present value. In order to achieve this objective, the analyst has to make a clear distinction between the financial and economic flows associated with the project. For the financial analysis, the cashflows represented the actual transactions of the project but the economic analysis operates with the "flow of economic resources". The equivalent of the financial revenues in the economic analysis is the "economic benefits" created by the project and added to the economy. The "economic costs" are the economic values of the resources forgone by other economic agents in order to allow the project to use these scarce resources.

The financial cashflow statements do not include any externalities created by the project because such externalities rarely materialize in the cash form. The economic analysis, by definition, has to include all such externalities in order to portray the true picture of the economic resource flows. The analyst must search and quantify any such externalities, even if they are not a part of the financial items. They can generate positive as well as negative externalities. For example investment in a rural road will lower the costs of normal transportation of goods and people but also it will allow the passage of emergency vehicles such as police and ambulance that will improve the level of security and will definitely benefit the local community.

In other words, the analyst should base the economic resource flows on the completed financial model, but the financial cashflows must be converted into their economic equivalents and any new items, i.e. externalities, must be quantified and included into the economic resource flows too. The economic net present value the project, discounted by the economic opportunity cost of capital (EOCK), will serve as the evaluation criterion for the project's net contribution to the economic welfare.

In order to use the projected financial cashflows for the economic analysis, so-called "economic conversion factor" (CF) has to be estimated for each financial item, according to the methodology of the economic analysis laid out in Chapter 5 of the *Manual (2003)*. Thus, Sections 6.2–6.4 will be devoted to the estimation of the project's conversion factors. Once all the cashflow items are furnished with their economic CFs, the analyst will be able to construct the Projected Statement of Economic Resource Flows and analyze it, as done in Section 6.5.

6.2 Estimation of Project's Economic Conversion Factors

An economic conversion factor is a number, used to convert the financial value of a resource into its true economic value. No doubt, most project analysts understand that the financial cost is different from the economic cost by the amount of distortions such as taxes, subsidies, market imperfections, and any other "externalities". The conversion factor incorporates the amount of all externalities and, thus, is a key element irreplaceable for the economic modeling because of its simple and appealing nature. The methodological framework of using conversion factors is given in Chapters 6 and 7 of the *Manual (2003)*.

The conversion factor can be found as the economic value divided by the financial value. If the calculated CF is greater than zero, this means that the economic value of this commodity is greater than its financial value. When the commodity in question is the project's output, a CF greater than unity means that the project produces a good that has a higher economic value than the financial price paid by the consumers. When the commodity is an input then the implication of its CF being greater than unity is that the true economic cost of this input is higher than the amount that the project pays for this input.

If the conversion factor of a commodity is smaller than unity and this commodity is a project's output, then the project is going to produce a good whose economic value is smaller than the financial price paid by the consumers. When a commodity with a CF less than one is a project input then the financial cost of the input paid by the project, is higher than its true economic cost.

A few basic economic parameters have to be introduced into the financial model in order to carry out estimation of economic conversion factors. The necessary parameters are the economic cost of capital (EOCK) in South Africa, and the economic cost of foreign exchange (FOREX). The first represents the economic discount rate used in the analysis to discount the annual flows of economic benefits and the costs of economic resources. Chapter 8 of the *Manual (2003)* concludes that the EOCK for South Africa is, in real terms, 11.0%.

The economic cost of foreign exchange is used in the analysis to estimate the economic conversion factors (CF) for most of the items used by the project. Given that even domestically manufactured products have, in fact, certain proportion of imported content – the economic cost of all products must account for the impact on the foreign exchange market on South Africa. Considering the project as an incremental investment, any addition consumption of foreign exchange by the project creates a distortion on the forex market in South Africa. The cost of foreign exchange is actually the premium which is paid on forex transactions. Chapter 9 of the *Manual (2003)* estimated the foreign exchange premium as 5.5% for the funds used to purchase traded commodities and 2.0% for the funds used to purchase non-traded commodities.

Also, a number of assumptions have to be made about the cost structure of certain cashflow items, and such assumptions are stated during the procedure of estimation of the economic conversion factors. While most of the project parameters are usually placed in the Table of Parameters, it is not unreasonable to keep certain non-repeating cost structure assumptions in the tables with the actual estimation of the economic conversion factors.

The estimation of the conversion factors can be split into two broad categories: basic conversion factors and project's specific conversion factors. The reason for such separation lays in the fact that many project's CFs are "composite" conversion factors, derived from "basic" conversion factors. Therefore, it is firstly needed to estimate all the basic CFs in order to proceed with project specific conversion factors. The basic conversion factors for the feed project can be listed as:

- Unskilled Labor
- Skilled / Semi-Skilled Labor and Local Management
- Administration and Foreign Management
- Construction Labor
- Operation and Maintenance Labor
- Labor
- Plant
- Materials
- Vehicles

- Electricity
- Water
- Transportation and Storage
- Administration
- Transportation

All the other conversion factors are derived from the basic CFs. Section 6.3 will deal with the estimation of the listed basic CFs, and Section 6.4 will handle the rest of the project's conversion factor.

6.3 Basic Conversion Factors

6.3.1 Unskilled Labor

The conversion factor for unskilled labor is estimated in Table 36, in accordance with the methodology outlined in Chapter 10 of the *Manual (2003)*. The specific case of conversion factor estimation relevant to the unskilled labor employed at the feed plant is the case of “urban project hiring unskilled labor and paying above market wage”. All the necessary parameters were already stated in Section 5.2.9, and now they are used to estimate the economic cost of unskilled labor hired by the project.

EOCL: The financial cost of unskilled labor hired by a similar urban project was computed as 1,566 Rand/month, inclusive all taxes and social security contributions as well as bonuses. To find the economic opportunity cost of labor (EOCL), a market equilibrium approach is used assuming that the unskilled labor market was in equilibrium before this project begins demanding a certain number of unskilled employees. Once the feed project employs addition workers, there will be an impact on both the informal sector and quasi-voluntary unemployed group. As mentioned in Section 5.2.9, the weights on the informal sector and quasi-voluntary unemployed are equal to 10% and 90% correspondingly. Their corresponding incomes are currently 651 Rand/month in the informal sector and 959 Rand/month for the quasi-voluntary unemployed. The economic opportunity cost of unskilled labor is, therefore, a weighted average of the two incomes forgone:

$$\begin{aligned} \text{EOCL}_{\text{Unskilled}} &= W_{\text{Informal}} * \text{Wage}_{\text{Informal}} + W_{\text{Quasi-Voluntary}} * \text{Wage}_{\text{Quasi-Voluntary}} \\ \text{EOCL}_{\text{Unskilled}} &= 10\% * 651 + 90\% * 959 = 928 \text{ Rand/month} \end{aligned}$$

Conversion Factor: By definition, the conversion factor for unskilled labor is the ratio of the economic opportunity cost to the financial cost. Note that the resulting conversion factor is just a number, and it does not have units assigned to it:

$$CF = \text{Economic Value} / \text{Financial Value}$$

$$CF_{\text{Unskilled}} = 928 / 1,566 = 0.59240$$

Externality: The total labor externality is the difference between the economic cost of unskilled labor and its financial cost, which can be found as:

$$\text{Externality} = \text{Economic Value} - \text{Financial Value}$$

$$\text{Externality}_{\text{Unskilled}} = 1,566 - 928 = 638 \text{ Rand/month}$$

It is useful to know the share of externality in the financial cost of labor (ρ^{TypeH}), which can be easily obtained by dividing the computed externality by its financial value:

$$\rho^{\text{TypeH}} = \text{Externality}_{\text{TypeH}} / \text{Financial Value}_{\text{TypeH}}$$

$$\rho^{\text{Unskilled}} = 638 / 928 = 40.8\%$$

Thus, the share of total externality in the unskilled labor is 40.8% of its financial cost. In further distributive analysis there will be a need to separate the total externality of labor of type H into the portions accruing to the labor as benefit ($\rho^{\text{TypeH}}_{\text{Labor}}$) and to the government in form of taxes ($\rho^{\text{TypeH}}_{\text{Gov}}$). Such a division can be easily performed since all the necessary data were already available in the Table of Parameters.

Share of Government Benefits: Referring to the section with unskilled labor, the analyst will find that although there is no personal income tax on the minimum wage paid to the unskilled employees, the government still is able to collect some 18.57% from the employer in the form of social security payments and alike. Note also, that this amount is not to be reduced by any forgone taxes because neither the informal sector nor the unemployed pay taxes. Thus, the amount of government collections from the unskilled labor is 235 Rand/month, or 18.57% of the minimum wage of 1,566 Rand/month. The share of the government benefits ($\rho^{\text{Unskilled}}_{\text{Gov}}$) in the total externality of unskilled labor is the ratio of the computed government collections to the total externality:

$$\rho^{\text{Unskilled}}_{\text{Gov}} = \text{Government Collections}_{\text{Unskilled}} / \text{Externality}_{\text{Unskilled}}$$

$$\rho^{\text{Unskilled}}_{\text{Gov}} = 235 / 638 = 36.8\%$$

Share of Labor Benefits: By the same approach, the amount of labor benefits can be found as the difference between the total externality and government collections, and the share of labor benefits in the total externality is derived from the ratio of the labor benefits to the amount of total externality:

$$\text{Labor Benefits}_{\text{Unskilled}} = \text{Externality}_{\text{Unskilled}} - \text{Government Collections}_{\text{Unskilled}}$$

$$\text{Labor Benefits}_{\text{Unskilled}} = 638 - 235 = 403 \text{ Rand/month}$$

and

$$\rho^{\text{Unskilled}}_{\text{Labor}} = \text{Labor Benefits}_{\text{Unskilled}} / \text{Externality}_{\text{Unskilled}}$$
$$\rho^{\text{Unskilled}}_{\text{Labor}} = 403 / 638 = 63.2\%$$

By definition, the shares of the government benefits and labor benefits in the total externality must add up to unity, and this is something useful the check:

$$\rho^{\text{Unskilled}}_{\text{Gov}} + \rho^{\text{Unskilled}}_{\text{Labor}} = 1$$
$$36.8\% + 63.2\% = 1$$

Thus, the analyst must have derived the following parameters: the economic CF for unskilled labor ($\text{CF}_{\text{Unskilled}}$), the share of the total externality in the financial cost of unskilled labor ($\rho^{\text{Unskilled}}$), the share government benefits in the externality of unskilled labor ($\rho^{\text{Unskilled}}_{\text{Gov}}$), and the share of labor benefits in the total externality of unskilled labor ($\rho^{\text{Unskilled}}_{\text{Labor}}$). The conversion factor will to be used to model the economic resource flow statement, and the other three parameters will be helpful in the distributive analysis to differentiate between the labor and government accrued externality.

6.3.2 *Skilled / Semi-Skilled Labor and Local Management*

For the purpose of economic analysis, the analyst has the full right to treat skilled labor, semi-skilled labor and local management as three different types of labor, as each having its own economic conversion factor. However, looking at the feed project closely reveals that these three types of labor can be described by a single economic conversion factor. The reason for such simplification is that all the three types here fall under the same category of “urban project hiring skilled labor and paying above market wage”, according to Chapter 10 in the *Manual (2003)*. The implication of this similarity is that the feed project pays a higher than the market wage, and a single conversion factor can be used. Of course, the base financial expenditures on each labor type, on which the economic resource flows are built, are different from one another. Therefore, the approach here is to derive a single economic CF, which can be used interchangeably for skilled labor, semi-skilled labor and local management in the economic analysis of this project. Table 37 shows the derivation of this economic conversion factor.

Private Supply Wage: As stated in Section 5.2.9, the project will attract 90% of skilled personnel from other sectors (Kd), where the average annual salary is taken as 153,960 Rand/year (equivalent of monthly wage of 12,830 Rand/month). Because there are various fringe benefits,

which, on the average, account for 17.07% of the wage rate, the private supply wage of labor attracted from other sectors is estimated as 180,241 Rand/year. This supply wage is actually the average annual salary of 153,960 Rand/year, adjusted up by the 17.07% of fringe benefits.

Income Taxes: The amount of personal income taxes paid by a similar project can be found as 44,129 Rand/year ($\text{Taxes}^{\text{Market}}$), which is a sum of the personal income tax of 35,409 Rand/year and a site tax of 8,720 Rand/year. For the personnel attracted from the other sectors, some amount of income taxes will be forgone. The amount of income taxes forgone can be estimated by multiplying the amount of personal income taxes paid by this project (44,129 Rand/year) by the share of the labor attracted from the other sectors (90%), which results in forgone annual taxes of 39,716 Rand/year.

EOCL: The EOCL for skilled labor can be approximated by the net-of-taxes market salary plus the amount of income taxes forgone. The economic cost is the supply wage of labor, decreased by the amount of taxes transferred to the government, plus the reduction in the tax collections from the other sectors:

$$\begin{aligned}\text{EOCL}_{\text{Skilled}} &= \text{Private Supply Wage} - \text{Taxes}_{\text{Skilled}}^{\text{Project}} + \text{Taxes}_{\text{Skilled}}^{\text{Forgone}} \\ \text{EOCL}_{\text{Skilled}} &= 180,241 - 44,129 + 39,716 = 175,828 \text{ Rand/year}\end{aligned}$$

Financial Cost of Labor: The resulting economic cost of skilled labor is the opportunity cost of the skilled personnel employed by the feed plant. The actual net annual salary paid by the project is 174,000 Rand/year, which is the annual equivalent of a 14,500-Rand monthly wage, and this net annual salary is higher than the computed EOCL. In addition to the annual salary of 174,000 Rand/year, the project also pays to the skilled employees 17.07% in fringe benefits, thus making the total financial cost of skilled labor equal to 203,702 Rand/year. Out of this amount, the government gets 51,089 Rand/year in the form of personal income taxes ($\text{Taxes}^{\text{Project}}$), as stated in Section 5.2.9.

Conversion Factor: It is now easy to compute the conversion factor for skilled labor, which is the ratio of the EOCL to the financial cost of skilled labor:

$$\begin{aligned}\text{CF}_{\text{Skilled}} &= \text{EOCL}_{\text{Skilled}} / \text{Financial Cost of Labor}_{\text{Skilled}} \\ \text{CF}_{\text{Skilled}} &= 175,828 / 203,702 = 0.86316\end{aligned}$$

Externality: The total labor externality created by the existing structure of payments for skilled labor can be found as the difference between the economic cost of labor and its financial cost:

$$\text{Externality}_{\text{Skilled}} = 203,702 - 175,828 = 27,874 \text{ Rand/year}$$

The share of externality in the financial cost of skilled labor is a ratio of the computed externality over the financial cost:

$$\rho^{\text{Skilled}} = 27,874 / 203,702 = 13.7\%$$

Share of Government Benefits: To calculate the share of the government-accruing benefits in the total externality, the analyst has to find the amount of taxes withheld by the government. The income tax on the salary paid by the project is 51,089 Rand/year, while the amount of income taxes forgone is 39,716 Rand/year, which means that the net tax collections are 11,373 Rand/year. Therefore, the share of government benefits in the total externality is 40.8%:

$$\begin{aligned}\rho^{\text{Skilled}}_{\text{Gov}} &= \text{Government Collections}_{\text{Skilled}} / \text{Externality}_{\text{Skilled}} \\ \rho^{\text{Skilled}}_{\text{Gov}} &= 11,373 / 27,874 = 40.8\%\end{aligned}$$

Share of Labor Benefits: Given the fact that the government benefits are estimated and the total externality is known, it is possible to find the amount of labor-accruing benefits as well as its share in the total externality. The amount of labor externality is found as the financial cost of skilled labor minus the private supply wage and plus the difference in the income taxes between the prevailing market wage and project's wage:

$$\text{Labor Benefits}_{\text{Skilled}} = \text{Financial Cost}_{\text{Skilled}} - \text{Private Supply Wage}_{\text{Skilled}} + (\text{Taxes}_{\text{Skilled}}^{\text{Market}} - \text{Taxes}_{\text{Skilled}}^{\text{Project}})$$

$$\text{Labor Benefits}_{\text{Skilled}} = 203,702 - 180,241 + (44,129 - 51,089) = 16,501 \text{ Rand/year}$$

therefore,

$$\begin{aligned}\rho^{\text{Skilled}}_{\text{Labor}} &= \text{Labor Benefits}_{\text{Skilled}} / \text{Externality}_{\text{Skilled}} \\ \rho^{\text{Skilled}}_{\text{Labor}} &= 16,501 / 27,874 = 59.2\%\end{aligned}$$

Having completed this section, the analyst should be able to derive such parameters as the economic CF for unskilled labor ($\text{CF}_{\text{Skilled}}$), the share of the total externality in the financial cost of unskilled labor (ρ^{Skilled}), the share government benefits in the externality of unskilled labor ($\rho^{\text{Skilled}}_{\text{Gov}}$), and the share of labor benefits in the externality of unskilled labor ($\rho^{\text{Skilled}}_{\text{Labor}}$). Note that the assumption is made about the conversion factor for skilled labor being equal to the conversion factor for semi-skilled labor and also to the CF of local management:

$$\text{CF}_{\text{Skilled}} = \text{CF}_{\text{Semi-Skilled}} = \text{CF}_{\text{Local Management}}$$

6.3.3 Administration and Foreign Management

The administrative positions at the project will be filled with qualified professional who have worked at the feed plant in the foreign country. There will be three permanent full-time managerial posts. The company plans to bring the necessary people from abroad, and this labor type fits into the case of “non-South Africans employed in South Africa”, according to Chapter 10 in *Manual (2003)*. Table 38 presents the estimation of the economic conversion factor for administration and foreign management.

As mentioned in Section 5.2.9, the project will pay the foreign employees a wage of 18,000 Rand/month, and it is assumed that 50% of their net income will be expatriated outside of South Africa. The personal income tax rate in South Africa is 25%. It is also assumed that the previous wage rate for these individuals was 12,000 Rand/month.

EOCL and Conversion Factor: Because the foreign employees have not been a part of the domestic labor force and they are not lured away from other sectors, the economic opportunity cost of such labor is simply the net-of-tax salary, adjusted for the foreign exchange premium. Since the personal income tax accrues to the government, it is not a cost component. The adjustment for foreign exchange premium must be made in order to account for the fact that the foreign individuals will transfer 50% of their incomes abroad, for which they will have to exchange South African Rand for dollars, thus creating an additional demand for the US dollar. The actual computation can be expressed as:

$$\begin{aligned} \text{EOCL}_{\text{Foreign}} &= \text{Wage}_{\text{Project}} * (1 - \text{Tax Rate}) + \text{Wage}_{\text{Project}} * (1 - \text{Tax Rate}) * \% \text{Expatriated} * \text{FOREX}^{\text{Traded}} \\ \text{EOCL}_{\text{Foreign}} &= 18,000 * (1 - 25\%) + 18,000 * (1 - 25\%) * 50\% * 5.5\% = 13,871 \text{ Rand/month} \end{aligned}$$

The estimation of the conversion factor is based on the project's wage and computed economic cost of foreign labor:

$$\text{CF}_{\text{Foreign}} = 13,871 / 18,000 = 0.77063$$

Externality: The total labor externality created by employing a foreign national at the feed plant can be found as the difference between the project's wage and EOCL:

$$\text{Externality}_{\text{Foreign}} = 18,000 - 13,871 = 4,129 \text{ Rand/month}$$

The share of externality in the financial cost of foreign labor is a ratio of the computed externality over the project's wage:

$$\rho^{\text{Foreign}} = 4,129 / 18,000 = 29.8\%$$

Shares of Government Benefits and Labor Benefits: Since the foreign national have not been in the domestic labor force, the government does not lose any taxes but it gains by the amount of the personal income taxes withheld. At the same time, the amount of foreign exchange losses due to the increased demand for dollars should be deducted from the government' benefits:

$$\begin{aligned} \text{Government Collections}_{\text{Foreign}} &= \\ &= \text{Wage}_{\text{Project}} * \text{Tax Rate} - \text{Wage}_{\text{Project}} * (1 - \text{Tax Rate}) * \% \text{Expatriated} * \text{FOREX}^{\text{Traded}} \\ \text{Government Collections}_{\text{Foreign}} &= 18,000 * 25\% + 18,000 * (1 - 25\%) * 50\% * 5.5\% = 4,129 \text{ Rand/month} \end{aligned}$$

What is appealing here is that the government benefits are equal to the total externality ($\rho^{\text{Foreign}}_{\text{Gov}} = 1$), meaning that there are no labor benefits ($\rho^{\text{Foreign}}_{\text{Labor}} = 0$). In fact, the foreign labor earns a higher wage rate than in the previous employment. The government collects full income tax on the foreign nationals but it also loses the premium on the additional foreign exchange demand if income repatriation takes place.

6.3.4 Construction Labor

The labor employed at the plant construction is treated as a separate item because this construction labor is a mix of the labor types discussed above. Table 39 is used to derive the CF for construction labor. The share of each labor type in the construction labor is obtained by using data from a civil works construction project, done in Limpopo Province. The actual project was hiring 370 people, 165 of whom were unskilled workers, 185 were skilled and semi-skilled employees, and 20 professional were managing the project. Thus, the shares of the different labor types are: 45% for unskilled labor, 50% for skilled and semi-skilled labor, and 5% for local management.

The assumption for this plant construction is that this labor structure will prevail, and the shares of the three labor types employed will be the same. This allows the analyst to derive a composite conversion factor for “construction labor” as a weighted average of the CFs of the three labor types:

$$\begin{aligned} \text{CF}_{\text{Construction Labor}} &= \sum_H (\% \text{Share}^{\text{TypeH}} * \text{CF}^{\text{TypeH}}) = \\ &= \% \text{Share}^{\text{Unskilled}} * \text{CF}^{\text{Unskilled}} + \% \text{Share}^{\text{Skilled}} * \text{CF}^{\text{Skilled}} + \% \text{Share}^{\text{Local Management}} * \text{CF}^{\text{Local Management}} \\ \text{CF}_{\text{Construction Labor}} &= 45\% * 0.59240 + 50\% * 0.86316 + 5\% * 0.86316 = 0.74242 \end{aligned}$$

The CF for construction labor will be frequently used in the estimation of the conversion factors for the different construction activities involving labor. Note that because the conversion

factors for skilled labor and management were assumed to be the same, a single CF is used for both. Also, the construction labor does not include foreign management because it is usual for such construction jobs to be done by a local firm.

6.3.5 Operation and Maintenance Labor

Table 40 estimates the conversion factor for operation and maintenance labor employed at the project. The composition of the labor force employed for the operation and maintenance works is different from the construction labor, and the assumed shares of the three basic labor types in such works are: 15% for unskilled labor, 35% for skilled and semi-skilled labor, and 50% for foreign management. The composite CF can be found as a weighted average of the basic labor conversion factors:

$$\begin{aligned}
 CF_{O\&Market\ Labor} &= \sum_H (\%Share^{TypeH} * CF^{TypeH}) = \\
 &= \%Share^{Unskilled} * CF^{Unskilled} + \%Share^{Skilled} * CF^{Skilled} + \%Share^{Foreign\ Management} * CF^{Foreign\ Management} \\
 CF_{O\&Market\ Labor} &= 15\% * 0.59240 + 35\% * 0.86316 + 50\% * 0.77063 = 0.77628
 \end{aligned}$$

6.3.6 Labor

The “labor” expense item corresponds to the total expenses on the plant’s employees, not including the administration and management. An assumption is made that the unskilled workers have a 70% stake in the total labor payment, while the skilled and semi-skilled personnel gets the remaining 30%. Table 41 shows the computation of a conversion factor for labor expenses, and the estimated CF for labor expenses can be found as:

$$\begin{aligned}
 CF_{Labor} &= \sum_H (\%Share^{TypeH} * CF^{TypeH}) = \%Share^{Unskilled} * CF^{Unskilled} + \%Share^{Skilled} * CF^{Skilled} \\
 CF_{Labor} &= 70\% * 0.59240 + 30\% * 0.86316 = 0.67363
 \end{aligned}$$

6.3.7 Plant

It is a commonly used term in the designing the civil works in Limpopo Province. The “plant” is a mixture of commodities needed for construction, and while there is no precise listing of the items comprising the plant, it is possible to assume its cost structure. Thus, the assumed components and their shares in the “plant” are: steel - 50.0%, cement - 10.0%, stone - 15.0%, sand

- 10.0%, asphalt - 8.0%, and heavy equipment - 7.0%. If the analyst possesses a more advanced knowledge of the plant components, they should be added to this list. Table 42 is used to derive a conversion factor for plant.

The economic conversion factor for the plant is, again, a weighted average of the CFs of its components. The individual CFs for all the plants components are obtained from the *Database (2003)*. An assumption is made that the freight and handling expenses from producer to port are equal to the freight and handling costs from producer to this project.

The biggest part of the plant is steel, and this steel would fall into one of the items in Chapters 72 -76 of the Harmonized Code, which all have the same conversion factor of 0.92544. Note that steel is an exportable item and the project uses steel as an input. Cement falls under the items of Chapter 25.01-25.24, and it is treated as an importable commodity with a CF of 0.92544. Stone and sand are non-traded items, and their conversion factor is taken as 0.95947. Asphalt is an importable commodity, which can be described in terms of item 271490.1 in Chapter 27, with a conversion factor of 0.84832. The heavy equipment used can be categorized as an importable component, being an item of Chapter 84.29-84.30, with the resulting conversion factor of 0.92544.

Given the list of conversion factors and shares of the plant components, the estimation of the CF for the plant becomes:

$$CF_{Plant} = \sum_H (\%Share^{TypeH} * CF^{TypeH})$$

$$CF_{Plant} = 50\%*0.92544 + 10\%*0.92544 + 15\%*0.95947 +$$

$$+ 10\%*0.95947 + 8\%*0.84832 + 7\%*0.92544 = 0.92778$$

6.3.8 Materials

This is another commonly used term in civil works construction, to describe the various materials consumed at the construction. Because the actual combination of such materials varies from place to place, an assumed list of material items is used for the purposes of this study. The following materials are taken: fuel - 30.0%, lubrication oils - 5.0%, wood - 20.0%, plastics - 27.0%, chemicals - 5.0%, electric supplies - 10.0%, and paint - 3.0%. An assumption is made that the freight and handling expenses from producer to port are equal to the freight and handling costs from producer to this project. Table 43 shows the results of conversion factor estimation.

Fuel is an internationally traded commodity, and actually imported into South Africa, the CF for it is taken from the *Database (2003)* as 0.67805. Lubrication oils are also imported and can be labeled with item 271011.52 of the Harmonized Code, with a conversion factor of 0.92544. Wood

is an exportable commodity for South Africa, and wooden materials for construction can be fit into Chapter 44.01-44.18 of the Harmonized Code, with a conversion factor of 0.92544. Plastics are importable and the best description for such materials is the item 391729.4 in the Harmonized Code, with a conversion factor of 0.81439. Chemicals can be also said to be imported, and being a part of Chapter 28.01-28.51, they have a conversion factor of 0.92544. The electric supplies are importable items belonging to Chapter 84.01-84.14 listing of the Harmonized Code, with a conversion factor of 0.92544. Paint is traded internationally and it can be fitted into the description of the items in Chapter 32.08-32.09, with a conversion factor of 0.84832.

Integrating all the available parameters into the formula, the conversion factor for the materials can be found as:

$$CF_{\text{Materials}} = \sum_H (\% \text{Share}^{\text{TypeH}} * CF^{\text{TypeH}})$$

$$CF_{\text{Materials}} = 30\% * 0.67805 + 5\% * 0.92544 + 20\% * 0.92544 + 27\% * 0.81439 + \\ + 5\% * 0.92544 + 10\% * 0.92544 + 3\% * 0.84832 = 0.81892$$

6.3.9 Vehicles, Electricity, Water, Transportation and Storage, Administration, and Transportation

Table 44 contains the conversion factors for vehicles, electricity, water, transportation and storage, administration, and transportation. A number of items are taken directly from the *Database (2003)*. For instance, the vehicles expenses fall into the description of item 870210.8 of the Harmonized Code, being importable and their conversion factor is equal to 0.78306.

Electricity and water are non-tradable items, and according to the *Database (2003)*, their conversion factors are respectively 0.96813 and 0.92544. Administration expenses are associated with the duties of the management, and the relevant conversion factor is the one for the foreign management, 0.77063. Transportation is again a non-tradable item, which has a CF of 0.84749, according to the *Database (2003)*.

The transportation and storage expenses of the plant can be broken into the separate transportation and storage expenses, assuming respective shares of 40% and 60%. The transportation conversion factor has been estimated above, and storage can be assigned the non-traded conversion factor for general building construction, which is stated as 0.88056. The weighted average of the conversion factors for transportation and storage is equal to 0.86733, which is indeed the conversion factor for the transportation and storage expenses.

6.4 Project Specific Conversion Factors

6.4.1 Workshop, Awning, Unloading Car Canopy, Boiler House, Underground Pond/Pump House

The workshop, awning, unloading car canopy, boiler house, underground pond/pump house are all components of the construction costs, their conversion factors will be used to estimate a single conversion factor for the construction. For simplicity, it is assumed that the workshop, awning, unloading car canopy, boiler house, underground pond/pump house have the same cost structure, which is: plant - 35%, materials - 10.0%, unskilled labor - 30.0% skilled and semi-skilled labor - 15.0%, and local management - 10.0%. The corresponding conversion factors were already obtained, and it allows the analyst to compute the composite conversion factor, as done in Table 45:

$$\begin{aligned} CF_{\text{Workshop, etc.}} &= \sum_H (\% \text{Share}^{\text{TypeH}} * CF^{\text{TypeH}}) \\ CF_{\text{Workshop, etc.}} &= 35\%*0.90747 + 10\%*0.77422 + 30\%*0.59240 + \\ &\quad + 15\%*0.86316 + 10\%*0.86316 = 0.80012 \end{aligned}$$

6.4.2 Assist Raw Material Warehouse, Finish Products Warehouse and Assisting House

Table 46 estimates a conversion factor for the assist raw material warehouse, finish products warehouse and assisting house. Again, a simplifying assumption is made about the assist raw material warehouse, finish products warehouse and assisting house having the same cost structure, and therefore the same conversion factor. The cost structure is taken as follows: plant - 20%, materials - 15.0%, unskilled labor - 40.0% skilled and semi-skilled labor - 18.0%, and local management - 7.0%. The conversion factor is a weighted average of the components' conversion factors:

$$\begin{aligned} CF_{\text{Assist Raw Material Warehouse, etc.}} &= 20\%*0.90747 + 15\%*0.77422 + \\ &\quad + 40\%*0.59240 + 18\%*0.86316 + 7\%*0.86316 = 0.76114 \end{aligned}$$

6.4.3 Steel Tank Warehouse

The same approach is used for the estimation of the CF for steel tank warehouse, whose conversion factor is derived in Table 47. The assumed cost structure is: plant - 60%, materials -

5.0%, unskilled labor - 18.0%, skilled and semi-skilled labor - 7.0%, and local management - 10.0%. The conversion factor can be easily found:

$$\begin{aligned} CF_{\text{Steel Tank Warehouse}} &= 60\%*0.90747 + 5\%*0.77422 + 18\%*0.59240 \\ &\quad + 7\%*0.86316 + 10\%*0.86316 = 0.85098 \end{aligned}$$

6.4.4 Gate House

Table 48 estimates a CF for the gate house. The components of the gate house are taken as: plant - 45%, materials - 5.0%, unskilled labor - 40.0%, skilled and semi-skilled labor - 5.0%, and local management - 5.0%. The conversion factor for the gate house is, therefore, computed by:

$$\begin{aligned} CF_{\text{Gate House}} &= 45\%*0.90747 + 5\%*0.77422 + 40\%*0.59240 + \\ &\quad + 5\%*0.86316 + 5\%*0.86316 = 0.78172 \end{aligned}$$

6.4.5 Weighbridge

The calculation of a CF for the weighbridge is performed in Table 49, and it is based on the following assumptions: plant - 50%, materials - 10.0%, unskilled labor - 20.0%, skilled and semi-skilled labor - 10.0%, and local management - 10.0%. The conversion factor for the weighbridge is, therefore, computed by:

$$\begin{aligned} CF_{\text{Gate House}} &= 50\%*0.90747 + 10\%*0.77422 + 20\%*0.59240 + \\ &\quad + 10\%*0.86316 + 10\%*0.86316 = 0.83689 \end{aligned}$$

6.4.6 Parking and Toilet

The costs of constructing the parking place and toilet are spread as follows: plant - 60%, materials - 5.0%, unskilled labor - 20.0%, skilled and semi-skilled labor - 10.0%, and local management - 5.0%. The computation of conversion factor is shown in Table 50, and can be found by formula:

$$\begin{aligned} CF_{\text{Parking \& Toilet}} &= 60\%*0.90747 + 5\%*0.77422 + 20\%*0.59240 \\ &\quad + 10\%*0.86316 + 5\%*0.86316 = 0.84557 \end{aligned}$$

6.4.7 Raw Material and Finish Products Laboratory

The last item of the plant construction costs is the Raw Material and Finish Products Laboratory, which is assumed to have: plant - 30%, materials - 30.0%, unskilled labor - 15.0%,

skilled and semi-skilled labor - 15.0%, and local management - 10.0%. Its conversion factor is computed in Table 51 as:

$$\begin{aligned} CF_{\text{Raw Material \& Finish Products Laboratory}} &= 30\%*0.90747 + 30\%*0.77422 + \\ &+ 15\%*0.59240 + 15\%*0.86316 + 10\%*0.86316 = 0.82886 \end{aligned}$$

6.4.8 Construction

The construction expenses, as discussed in Section 5.4, are composed of a number of components and, therefore, the estimation of a CF for the construction can be based on the cost shares of these components and their respective conversion factors. In other words, a weighted average approach to the estimation of the conversion factor can be successfully employed once again. Table 52 shows the results of the estimation.

Expenditure and Share: The amount of expenditure on each component is linked to the Table of Investment Costs, resulting in a total of 37,807,744 Rand₂₀₀₂. The cost shares of individual components (α_{ItemM}) are easily calculated, for instance, the 3,108,433 Rand₂₀₀₂ expense on the workshop corresponds to an 8.22% share of the total construction costs. Note that the sum of the shares is equal to unity, by definition:

$$1 = \sum_M (\alpha_{\text{ItemM}}).$$

Conversion Factor: The individual CFs are referred to their appropriate conversion factors, derived in the preceding sections. The composite conversion factor for construction, computed as 0.79199, is derived by taking a weighted average of the cost shares and their CFs:

$$CF_{\text{Construction}} = 0.79199 = \sum_M (\alpha_{\text{ItemM}} * CF_{\text{ItemM}})$$

Labor Benefit Share in Externalities: This is an additional column, needed to estimate the share of labor externality for the distributive analysis. Later, in the stakeholder impact assessment, the analyst may need to figure out the share of labor-accrued externalities from the total externality of a cashflow item. For many construction expenses, there is a substantial portion of labor costs, which generate an economic externality to the owners of the resource. Given the stated labor parameters, it is possible to estimate the share of such labor benefits in the total externality.

The labor content in each construction item is a sum of the three types of labor: unskilled, skilled and local management. The cost shares of the different labor types in each construction component ($\beta_{\text{ItemM}}^{\text{TypeH}_{\text{Labor}}}$) are also stated in the preceding sections. For example, the workshop cost structure assumes that the cost shares are: $\beta_{\text{Workshop}}^{\text{Unskilled}_{\text{Labor}}} = 30\%$, $\beta_{\text{Workshop}}^{\text{Skilled}_{\text{Labor}}} = 15\%$,

and $\beta_{\text{Workshop}}^{\text{Local Management Labor}} = 10\%$. The remaining cost of the workshop comes from the cost of the plant (35%) and materials (10%).

The share of labor benefits in the total labor externality for each type of labor ($\rho^{\text{TypeH Labor}}$) has been already estimated in the computation of basic labor conversion factors. The share of labor benefits in total externality for each type of labor were estimated as: $\rho^{\text{Unskilled Labor}} = 63.2\%$, $\rho^{\text{Skilled Labor}} = 59.2\%$, and $\rho^{\text{Local Management Labor}} = 59.2\%$.

The cost share of the workshop in the total construction costs (α_{Workshop}) is equal to 8.22%. Thus, all the required parameters are in place to be integrated into a single formula estimating the share of labor externality in workshop in the total externality for construction:

$$\begin{aligned} \text{Labor Benefits Share}_{\text{Workshop}} &= \\ &= \alpha_{\text{Workshop}} * (\beta_{\text{Workshop}}^{\text{Unskilled Labor}} * \rho^{\text{Unskilled Labor}} + \\ &\quad + \beta_{\text{Workshop}}^{\text{Skilled Labor}} * \rho^{\text{Skilled Labor}} + \\ &\quad + \beta_{\text{Workshop}}^{\text{Local Management Labor}} * \rho^{\text{Local Management Labor}}) \end{aligned}$$

$$\text{Labor Benefits Share}_{\text{Workshop}} = 8.22\% * (30\% * 63.2\% + 15\% * 59.2\% + 10\% * 59.2\%) = 2.77\%$$

Note that the computed 2.77% labor externality for workshop is just a single item of the construction costs, and the same formula is used for all the other construction components in order to find their own labor externality. Let's take another example, parking, to demonstrate the mechanics once again. The share of parking in the total construction costs is given ($\alpha_{\text{Parking}} = 1.34\%$), and the labor cost shares in awning are: $\beta_{\text{Parking}}^{\text{Unskilled Labor}} = 20\%$, $\beta_{\text{Parking}}^{\text{Skilled Labor}} = 10\%$, and $\beta_{\text{Parking}}^{\text{Local Management Labor}} = 5\%$:

$$\begin{aligned} \text{Labor Benefits Share}_{\text{Parking}} &= \\ &= \alpha_{\text{Parking}} * (\beta_{\text{Parking}}^{\text{Unskilled Labor}} * \rho^{\text{Unskilled Labor}} + \\ &\quad + \beta_{\text{Parking}}^{\text{Skilled Labor}} * \rho^{\text{Skilled Labor}} + \\ &\quad + \beta_{\text{Parking}}^{\text{Local Management Labor}} * \rho^{\text{Local Management Labor}}) \end{aligned}$$

$$\text{Labor Benefits Share}_{\text{Parking}} = 1.34\% * (20\% * 63.2\% + 10\% * 59.2\% + 5\% * 59.2\%) = 0.29\%$$

Note that the paint does not have labor expenses, and therefore it does not have a labor share. The aggregate labor externality for the construction is a sum of all labor externalities of the individual construction components:

$$\text{Labor Benefits Share}_{\text{Construction}} = \sum_M (\text{Labor Externality Share}_{\text{ItemM}}) = 34.08\%$$

The computed share of labor externalities in the total externalities means that 34.08% of the total economic externality, generated by this construction activity, will accrue to the labor. The rest of the economic externality will accrue to the government in terms of taxes and tariff

collections. Note that the share of labor externalities is based on the amount of the total externalities, and it is not based on the financial cost.

6.4.9 Freight and Traveling

The freight and traveling expenses have been stated in Section 5.4.4, and it is easy to find the individual shares in the total amount of the freight and traveling costs. Again, the weighted average approach is used to estimate the conversion factor for freight and traveling in Table 53.

The freight and traveling costs are a type of transportation expense and that is why the conversion factor for transportation (0.86733) is used here for both of them. The statutory cost is assigned with the conversion factor of handling (0.96575). The local costs are also likely to be of transportation nature, and the transportation conversion factor is assumed here. The value added tax is a pure distortion, and its conversion factor is equal to zero by definition. The insurance expense is assumed to have come from a competitive industry, with no distortions, resulting in a conversion factor of unity. Thus, the conversion factor for freight and traveling is a weighted average of its components' conversion factors:

$$CF_{\text{Freight and Traveling}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.86550$$

6.4.10 Mounting and Debugging Cost

Such costs are incurred during the installation of the plant's equipment and machinery. The conversion factor for mounting and debugging costs will be embedded into the conversion factors of the equipment. Table 54 estimates a conversion factor for mounting and debugging costs. The assumed cost proportions for the mounting and debugging expenses are: unskilled labor - 40%, skilled/semi-skilled labor - 40%, and foreign management - 20%. Taking their weighted average with the corresponding conversion factors yields:

$$CF_{\text{Mounting and Debugging}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.73635$$

6.4.11 Assist Material

Some assist material is used for the installation of the plant's equipment. The assumed content of such material is as follows: wood - 20%, plastic - 37%, cement - 5%, paint - 8%, electric supplies - 15%, and steel - 15%. The economic conversion factors for these items can be traced

back to the estimation of the CF for materials. The resulting conversion factor for assist material is computed in Table 55:

$$CF_{\text{Assist Material}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.87818$$

6.4.12 Equipment

The long list of the equipment items have been already presented in the Table of Investment Costs. In order to come up with a single conversion factor for the plant's equipment, it is needed to take a weighted average of the conversion factors for all the equipment items. The easiest way to do this task is to find a CF for each section of the equipment, and then to proceed with the estimation of a single composite CF, as done in Table 56.

Expenditure and Share: The expenditure on each of the component of the equipment is taken from the Table of Investment Costs, and the percentage share of each component is computed based on the total equipment costs, amounting to 49,196,311 Rand₂₀₀₂. For example, the cost of the “Raw Material, Drying and Storage Equipment” is 15,841,487 Rand₂₀₀₂, which results in a share of 32.2%. The summation of all the cost shares, by definition, must add up to unity: 1

$$= \sum_M (\alpha_{\text{ItemM}}).$$

Conversion Factor: The conversion factor for each component is also referred back to the calculations done in the last two columns of the Table of Investment Costs. As already discussed in Section 5.4.5, the last two columns contain the individual items' CFs and their contribution to the section's CF, which is a product of the individual CF and cost share of the item, and the composite CF of a section is computed as a sum of all contributions. An example of such calculation was given in Section 5.4.5 with the CF for the “Raw Material, Drying and Storage Equipment”, which was found to be:

$$CF_{\text{Raw Material, Drying and Storage Equipment}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.92110$$

Let's trace back the calculation of the CF for the “Feed Production Equipment”, which has six sections. Since the composite CF for the “section of raw material, receive and receiving sieve” is estimated as 0.92544, then the product of this CF and section's share in total costs will show the contribution of this section to the single CF for the “feed production equipment”. Thus, below the computed share in feed production equipment costs, this contribution to the aggregate CF is computed as 0.07120. The aggregate CF for the “feed production equipment” is found as 0.92544, which the sum of all sections' contributions, as shown in Table V.

Table V. Estimation of Economic Conversion Factor for Feed Production Equipment.

Section:	Share in Costs	* Composite CF	= Contribution
Section of Raw Material, Receive & Receiving Sieve	7.69%	0.92544	0.07120
Crush Section	14.44%	0.92544	0.13360
Dispensing and Mixture Section	21.24%	0.92544	0.19653
Pelletize Section	42.16%	0.92544	0.39020
Package Section	9.29%	0.92544	0.08600
Assistance Section	5.18%	0.92544	0.04791
CF for Feed Production Equipment	(100.0%)		0.92544

The conversion factor for the “Feed Briquetting Process Equipment” was also estimated by the weighted average formula:

$$CF_{\text{Feed Briquetting Process Equipment}} = 0.92544 = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}})$$

The estimation of the CF for the “Electronic and Internet Control System” was already performed in Section 5.4.5. The derived economic conversion factor is 0.87512. It is assumed that the “Office Equipment” has similar cost content as the electronic and internet control system, and the same CF can be used. The conversion factor for “Freight and Traveling” was estimated above, and it is found equal to 0.86468. To summarize all these findings, the final single CF for equipment is derived in Table VI.

Table VI. Estimation of Economic Conversion Factor for Equipment.

Equipment Type:	Share in Costs	* Composite CF	= Contribution
Raw Material, Drying and Storage Equipment	32.20%	0.92110	0.297
Feed Production Equipment	35.54%	0.92544	0.329
Feed Briquetting Process Equipment	13.02%	0.92544	0.120
Electronic and Internet Control System	7.22%	0.87512	0.063
Freight and Traveling	9.87%	0.86550	0.085
Office Equipment	2.15%	0.87512	0.019

CF for Equipment	(100.0%)	0.91341
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Labor Benefits Share in Externalities: This column is needed to find the share of labor benefits in the total externality, and its estimation is identical to the procedure performed in Section 6.4.8. The only additional parameter is v_{ItemH} , which is the share of the item H in component M of the total equipment cost:

$$\begin{aligned} \text{Labor Benefits Share}_{ItemM} = & \\ = & \alpha_{ItemM} * v_{ItemH} * (\beta_{ItemH}^{\text{Unskilled Labor}} * \rho^{\text{Unskilled Labor}} + \\ & + \beta_{ItemH}^{\text{Skilled Labor}} * \rho^{\text{Skilled Labor}} + \\ & + \beta_{ItemH}^{\text{Local Management Labor}} * \rho^{\text{Local Management Labor}}) \end{aligned}$$

Let's derive the labor externality share in the "Raw Material, Drying and Storage Equipment", which accounts for 32.2% of the total equipment costs ($\alpha_{\text{Raw Material, Drying and Storage Equipment}}$). At the same time, the labor input is needed only for the mounting and debugging tasks, which is found to be only 2.01% of the total costs of the "Raw Material, Drying and Storage Equipment" ($v_{\text{Mounting \& Debugging}}$). The parameters of the three basic types of labor in the mounting and debugging costs are given as:

$$\begin{aligned} \beta_{\text{Mounting \& Debugging}}^{\text{Unskilled Labor}} &= 40\%, & \rho^{\text{Unskilled Labor}} &= 63.2\%, \\ \beta_{\text{Mounting \& Debugging}}^{\text{Skilled Labor}} &= 40\%, & \rho^{\text{Skilled Labor}} &= 59.2\%, \\ \beta_{\text{Mounting \& Debugging}}^{\text{Local Management Labor}} &= 20\%, & \rho^{\text{Local Management Labor}} &= 59.2\%. \end{aligned}$$

Therefore:

$$\begin{aligned} \text{Labor Benefits Share}_{\text{Raw Material, Drying and Storage Equipment}} &= 32.2\% * 2.01\% * \\ & * (40\% * 63.2\% + 40\% * 59.2\% + 20\% * 59.2\%) = 0.32\% \end{aligned}$$

By the same method, all the other components of the equipment are processed. The aggregate share of labor benefits in the equipment externality is a sum of the computed components' shares:

$$\text{Labor Benefits Share}_{\text{Equipment}} = \sum_M (\text{Labor Benefits Share}_{ItemM}) = 0.52\%$$

6.4.13 Audit and Accounting Services

Table 57 estimates the conversion factor for audit and accounting services. The assumed cost proportions for the audit and accounting services are: unskilled materials – 15%, skilled/semi-skilled labor - 15%, and foreign management - 70%. Taking their weighted average with the corresponding conversion factors yields:

$$CF_{\text{Audit and Accounting Services}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.79175$$

6.4.14 Advertising

The calculation of a CF for the advertising is performed in Table 58 and it is based on the following assumptions: materials - 50.0%, skilled and semi-skilled labor - 20.0%, and local management - 30.0%. The conversion factor for the advertising is, therefore, computed by:

$$CF_{\text{Advertising}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.84104$$

6.4.15 Equipment Mechanic Service

Table 59 is used to estimate the CF for the equipment mechanic service. The costs of equipment mechanic service are assumed to be: lubrication oils - 15.0%, plastics - 10.0%, chemicals - 10.0%, electric supplies - 10.0%, paint - 5.0%, unskilled labor - 10.0%, skilled and semi-skilled labor - 35.0%, and foreign management - 5.0%. The conversion factor can be found by formula:

$$CF_{\text{Equipment Mechanic Service}} = \sum_H (\text{Share}_{\text{ItemH}} * CF_{\text{ItemH}}) = 0.84764$$

6.4.16 Office and Transportation Services

The office and transportation services expenses are assumed to consist of equal parts of administration and transportation, therefore, its conversion factor is computed in Table 60 as:

$$CF_{\text{Office and Transportation Services}} = 50\% * 0.77063 + 50\% * 0.84749 = 0.80906$$

6.4.17 Business Travel

The business travel expenses are assumed to be 50% in the fuel costs, and the other 50% of transportation, and the conversion factor is computed in Table 61 as:

$$CF_{\text{Business Travel}} = 50\% * 0.67805 + 50\% * 0.84749 = 0.78819$$

6.4.18 Feed Ingredients

Section 5.2.17 described the feed ingredients content as having 50% of tradable components, 40% of non-tradable components, 8% of transportation costs, and 2% of handling expenses. Given the high proportion of tradable components, the feed ingredients should be treated as tradable input, according to the methodology laid out Chapter 6 of the *Manual (2003)*. Table 62 carries out the estimation of a conversion factor for feed ingredients. The starting point of the estimation is to find the financial values of each feed ingredients component. The financial cost of feed ingredients was set at 950 Rand/ton, which implies that the tradable components worth 475 Rand/ton, non-tradable 380 Rand/ton, while transportation and handling costs account for 76 and 19 Rand/ton respectively.

Unadjusted Conversion Factor: This is the economic conversion factor describing the discrepancy between the financial and economic values of a commodity, but not adjusted for the foreign exchange premium. In the absence of the conversion factor data for these components, and given the fact that most basic agriculture commodities are VAT exempt, the unadjusted conversion factors assumed for the tradable and non-tradable components are equal to one. The handling expenses are subject to VAT, and therefore are assumed to have a CF of 0.93. The adjusted economic conversion factor for transportation expenses was already estimated as 0.84749 in Section 6.3.9, which already includes the adjustment for the foreign exchange premium, and that is why the cells with the transportation calculations are skipped.

Unadjusted Economic Price: The unadjusted economic price (P_e^{Unadj}) is simply a product of the financial price and the unadjusted conversion factor. For instance, the unadjusted economic value of handling is only 17.7 Rand/ton, with the difference created by the VAT tax.

Traded Content: This states the percentage share of tradable inputs in each feed component. Because even a purely non-traded commodity may, and usually does contain, some traded inputs, and any additional consumption of these inputs will result in an additional foreign exchange demand. It has been assumed that the traded content of the tradable feed ingredients components is 100%, non-tradable components have 30% of traded inputs, and handling has a 45% traded share.

Foreign Exchange Premium: As already mentioned, any additional consumption of traded input will eventually impact on the country's demand for the foreign exchange. Because South Africa has a foreign exchange premium of 5.5% on tradable commodities and 2.0% on non-tradable commodities, this premium must be included in the economic cost of a commodity. The amount of the premium can be calculated as a product of the financial price times the share of tradable content and times the corresponding foreign exchange premium:

$$\text{FOREX Premium}_{\text{ItemM}} \text{ (Rand/ton)} = \text{Financial Price}_{\text{ItemM}} \text{ (Rand/ton)} * \left(\begin{array}{l} \text{Tradable Content}_{\text{ItemM}} \text{ (\%)} * \text{FOREX Premium on Tradable} \text{ (\%)} \\ + \text{Non-Tradable Content}_{\text{ItemM}} \text{ (\%)} * \text{FOREX Premium on Non-Tradable} \text{ (\%)} \end{array} \right)$$

$$\text{FOREX Premium}_{\text{Handling}} = 19.0 * (45\% * 5.5\% + 55\% * 2.0\%) = 0.7 \text{ Rand/ton}$$

Adjusted Economic Price: This is the final economic value of a component (P_e^{Adj}), computed as a sum of the unadjusted economic value and the amount of foreign exchange premium:

$$P_e^{\text{Adj}}_{\text{ItemM}} \text{ (Rand/ton)} = P_e^{\text{Unadj}}_{\text{ItemM}} + \text{FOREX Premium}_{\text{ItemM}}$$

$$P_e^{\text{Adj}}_{\text{Handling}} = 17.7 + 0.7 = 18.3 \text{ Rand/ton}$$

For the transportation expenses, its adjusted economic value is derived by multiplying the financial cost of transportation by its conversion factor.

The total of economic values of the feed ingredients components adds up to 969.9 Rand/ton, which is a higher figure than the financial cost of feed ingredients. The conversion factor for feed ingredients can be found as:

$$CF_{\text{Feed Ingredients}} = \text{Economic Cost}_{\text{Feed Ingredients}} / \text{Financial Cost}_{\text{Feed Ingredients}}$$

$$CF_{\text{Feed Ingredients}} = 975.5 / 950.0 = 1.02681$$

The calculated conversion factor implies that the economic cost of feed ingredients is greater than the financial price the feed manufacturers pay for it. The difference is mostly attributed to the foreign exchange premium on the traded components. In other words, the feed manufacturers do not pay the full economic cost of the feed ingredients.

6.4.19 Change in Accounts Payable

Since the amount of accounts payable is assumed to follow the direct operating cost, then its economic conversion factor can be rightly derived from the conversion factors of the direct operating costs. Table VII below and Table 63 in Annex A both illustrate the procedure, and finds a conversion factor of 1.02301 for the change in accounts payable.

Table VII. Estimation of Economic Conversion Factor for Change in Accounts Payable.

Direct Costs:	PV of Costs	Share	*	CF	=	Contribution
Feed Ingredients	1,934,038,122	98.2%		1.02681		1.008
Labor	11,911,257	0.6%		0.67363		0.004

Electricity	5,685,372	0.3%	0.96813	0.003
Water	2,546,201	0.1%	0.92544	0.001
Equipment Mechanic Service	6,020,188	0.3%	0.84764	0.003
Transportation and Storage	10,125,047	0.5%	0.86733	0.004
Total	1,970,326,188	100.0%		1.02301

6.4.20 Feed

Table 64 is dedicated to the estimation of an economic conversion factor for feed. The estimation of the economic conversion factor for feed is somewhat technically complex, but it follows the same logic ruling the feed price determination as being a function of the feed ingredients cost and plant's milling cost. In principle, the economic conversion factor for feed is also found with the help of the basic identity:

$$CF_{\text{Feed}} = \text{Economic Value}_{\text{Feed}} / \text{Financial Value}_{\text{Feed}}$$

Economic Value: While the financial value of feed is determined by the interaction of the feed ingredients cost and milling cost, the economic value has to be derived from the available data. The methodological framework for the estimation of the economic value for feed is laid out in Chapter 7 of the *Manual (2003)*. The economic value of feed is a weighted average of the demand and supply prices of feed:

$$\text{Economic Value}_{\text{Feed}} = W_d * P_d + W_s * P_s$$

Starting with this formula, the analyst will realize that the weights on the demand and supply sides were already estimated, using the demand and supply elasticities in Section 5.2.21, and they were found to be: $W_d = 0.11$ and $W_s = 0.89$. Such distribution of weights implies that any additional feed production will have a substantially stronger impact on the existing producers, rather than on the consumers. In other words, the cut-back in the production of the other manufacturers will account for 89%, and the newly generated consumption will be the remaining 11%.

The feed market is dominantly competitive and there is no tax or subsidy on most of the feeds, which allows us to make a simplifying assumption that the feed demand price is equal to supply price ($P_d = P_s = P_m$). In other words, the market price paid by the consumers is equal to their perception of the value of feed needed as an input in the meat production, and, at the same time,

the price of feed received by the manufacturers is equal to their long-term average production costs, including the opportunity cost of capital.

While the financial prices on the demand and supply side can be said to be equal, there is an foreign exchange effect and taxes impact on the supply side, due to the fact that the existing producers will give up some of their production and release economic resources for other productive use, which will have an influence on the input resources allocation within the economy. Because there are economic externalities on the feed ingredients and milling cost, any re-allocation of these resources will create distortions equal to the difference between the financial cost of an input and its economic cost. A little modification of the economic value formula is, therefore, required in order to account for this impact:

$$\text{Economic Value}_{\text{Feed}} (\text{Rand}_{2002}/\text{ton}) = W_d * P_d + W_s * P_s - W_s * \text{Input Distortions}_{\text{Feed}}$$

The input distortions in the formula include all the distortions in the inputs used in the feed manufacture process. Note that the input distortion is only applicable to the supply side of the economic feed valuation. The negative sign of the net input distortions here represents the release of resources, otherwise directed at the feed production by other producers. In other words, the other producers will release economic resources previously used in the feed production, and the value of input cost distortions must be deducted from the economic value of the feed produced by this plant.

Distortions in Feed Ingredients: Now, the real issue is to estimate the amount of input distortions. To simplify the matter, the analyst may think of the total distortions as being created by the distortions in the feed ingredients and distortions in the cost of milling:

$$\text{Input Distortions}_{\text{Feed}} (\text{Rand}_{2002}/\text{ton}) = \text{Input Distortions}_{\text{Ingredients}} + \text{Input Distortions}_{\text{Milling}}$$

For the feed ingredients part, it is relatively easy to find the amount of distortions created by the 0.9-weighted pull-back on the supply side. Since the cost of feed ingredients is 950.0 Rand₂₀₀₂/ton and the computed conversion factor of feed ingredients is 1.02681, then the amount of distortions in the cost of ingredients can be approximated by formula:

$$\text{Input Distortions}_{\text{Ingredients}} (\text{Rand}_{2002}/\text{ton}) = \text{Cost}_{\text{Feed Ingredients}} * (1 - \text{CF}_{\text{Feed Ingredients}})$$

$$\text{Input Distortions}_{\text{Ingredients}} = 950 * (1 - 1.02681) = -28.6 \text{ Rand}_{2002}/\text{ton}$$

What the minus sign implies here is that there is negative forex adjustment on the cost of inputs going into the feed production, i.e. the economy suffers a loss, which is not reflected in the financial cashflows, if there is an expansion of feed production. The loss comes about due to an

increased use of the feed ingredients, and consequent demand for the foreign exchange, which has been determined as the major contributor to the feed ingredients economic conversion factor.

When this negative distortion is actually entered into the formula for estimation of the economic value of feed, its sign will change to positive. This is explained by the fact that the 0.9-weighted supply side adjustment implies a reduction of feed production by other manufacturers, and a lower consumption of feed ingredients and a consequent release of the foreign exchange previously used to purchase the feed ingredients. Thus, the input distortions on the ingredients side will increase the economic value of feed, because foreign exchange is actually saved from being used by the existing manufacturers in the feed production.

PV of Costs and Shares in Milling Cost: The estimation of input distortion in the milling cost is more complex because the total cost of milling is actually composed of variety of items. By definition, the milling cost includes all the other investment costs and operating expenses, with the exception of the cost of feed ingredients which is excluded. To enlist all the individual components of the milling costs, the analyst should exclude the cost of ingredients from the total investment and operating costs.

The best way to do this task is to take the present value of each and every cost item, and then exclude the present value of the feed ingredients. Examination of Table 64 can explain how the present values are obtained. Each cashflow item has been computed with a present value, according to the formula:

$$PV_{ItemM}(Rand_{2002}) = NPV(EOCK^{Real}, Annual CF_{ItemM}^{Real}_{2003}:Annual CF_{ItemM}^{Real}_{2013}) + Annual CF_{ItemM}^{Real}_{2002}$$

$$PV_{Labor} = NPV(11\%, Labor^{Real}_{2003}:Labor^{Real}_{2013}) + Labor^{Real}_{2002} = 11,911,257 Rand_{2002}$$

Note that the PV formula is based on the cashflow statement from the banker's point of view, where the loan items and grant are excluded. For the investment cost items, their liquidation values are actually deducted from the corresponding investment costs to reflect the fact that the owners will be able to recoup some of the initial investment costs by selling off useful assets.

As a result, the column with present values of project's costs contains the PVs of all financial costs, including the PV of the ingredients costs. The total present value of costs is computed as 2,187,324,982 Rand₂₀₀₂, which includes the present value of all investment and operating costs, except for loan and grant items.

It is now possible to exclude the PV of ingredients costs from the listing, and the next column performs this task. The total present value is now stands at 238,359,464 Rand₂₀₀₂, which is net of the 1,934,038,122 Rand₂₀₀₂ feed ingredients cost. The new total is nothing else than the present value of the milling costs, and using it as a base, the computation of the share of each individual

item is carried out. For example, since the present value of land is 768,191 Rand₂₀₀₂, its share in the PV of the total costs is 0.32%. Thus, the share of land costs in the total milling costs is 0.32%, and the analyst can figure out the actual land expenses per ton of feed produced by the plant.

Share of Feed Ingredients Cost in Feed: At this point, the actual share of the ingredients in the feed production can be found as well as the share of the milling costs. The share of feed ingredients is found as the PV of the ingredients costs over the PV of the total costs:

$$\alpha_{\text{Ingredients}} = 1,934,038,122 \text{ Rand}_{2002} / 2,187,324,982 \text{ Rand}_{2002} = 0.88$$

Also, the share of the milling cost is simply the ratio of the PV of the milling costs over the PV of the total costs:

$$\alpha_{\text{Milling}} = 238,359,464 \text{ Rand}_{2002} / 2,187,324,982 \text{ Rand}_{2002} = 0.12$$

By definition, the shares must add up to one which indeed holds true ($\alpha_{\text{Ingredients}} + \alpha_{\text{Milling}} = 1$). The derived parameters are used in the Table of Parameters (Section 5.2.21), in the Schedule of Feed Ingredients and Feed Prices (Section 5.6) and in the feed demand determination model (Section 5.7).

Values in Milling Cost: In order to find the value of each cost item, the computed cost share should be multiplied by the share of milling, taken from the Table of Parameters. Thus, the value of land costs would be 0.5 Rand₂₀₀₂/ton, which is a product of a cost share of 0.35% and milling fee of 258.8 Rand₂₀₀₂/ton. The same action is performed for all the milling cost components, in order to create an itemized cost structure of milling.

Distortion in Milling Cost: The amount of input distortion per item is computed on the basis of the obtained earlier individual economic conversion factors. Because the conversion factors already account for all the distortions such as taxes, tariffs, subsidies, foreign exchange premium and so on, then the difference between the item's conversion factor and unity is really the amount of disturbances per unit. The formula used here utilizes the conversion factors found beforehand:

$$\text{Input Distortions}_{\text{ItemM}} (\text{Rand}_{2002}/\text{ton}) = \text{Value}_{\text{ItemM}}^{\text{Milling Costs}} * (1 - \text{CF}_{\text{ItemM}})$$

$$\text{Input Distortions}_{\text{Land}} = 0.5 * (1 - 1) = 0 \text{ Rand}_{2002}/\text{ton}$$

$$\text{Input Distortions}_{\text{Labor}} = 7.1 * (1 - 0.67363) = 2.31 \text{ Rand}_{2002}/\text{ton}$$

Having computed all individual cost items, a total amount of input disturbance in the cost of milling can be found as a sum of their values. This amount adds up to 36.5 Rand₂₀₀₂/ton, which represents the value of the resource externalities in the milling cost of feed released due to a reduction in the production by other manufacturers. The net input distortion of the milling cost is a positive figure here but when used in the formula for the economic value of feed it accrues a

negative sign there, which means that the economy loses some taxes and tariffs on the milling cost components.

Conversion Factor for Feed: At this point, the estimation of the conversion factor for feed becomes possible. First, let's find the net amount of input distortion per ton of feed, which is the sum of the distortions in feed ingredients costs and distortions in the milling cost:

$$\text{Input Distortions}_{\text{Feed}} = (-28.6) + 36.5 = 7.9 \text{ Rand}_{2002}/\text{ton}$$

Thus, the reduction in feed production by other manufacturers will release foreign exchange worth 28.6 Rand/ton but, at the same time, such a reduction in the feed production by other manufacturers will cause a reduction of taxes, tariffs collection as well as loss of labor externalities worth 36.5 Rand per ton of feed. The net input distortion is an economic loss of 7.9 Rand per ton of feed, which is applicable on the 0.9-weighted supply-side response in the feed market.

Then, the economic value of feed can be estimated as the weighted average of the supply and demand prices minus the amount of net input distortions per ton. Note that the financial supply and demand prices are assumed to be equal:

$$\begin{aligned} \text{Economic Value}_{\text{Feed}} (\text{Rand}_{2002}/\text{ton}) &= W_d * P_d + W_s * P_s - W_s * \text{Input Distortions}_{\text{Feed}} \\ \text{Economic Value}_{\text{Feed}} &= 0.11 * 1,209 + 0.89 * 1,209 - 0.89 * 7.9 = 1,202 \text{ Rand}_{2002}/\text{ton} \end{aligned}$$

With the computed economic value of feed being smaller than its financial price, the analyst should expect the resulting conversion factor to be somewhat below unity:

$$CF_{\text{Feed}} = 1,202 / 1,209 = 0.99415$$

This conversion factor has a strong implication for the economic analysis. The economic value of the feed produced by this project is found to be smaller than the price charged to the consumers. The reason for this, as we have seen, lays in the input distortion effect, which affects the foreign exchange equilibrium, impact on the tax collections, and on labor externalities. A further analysis will have to look at other economic resource flows in order to determine the net economic impact.

6.4.21 Summary of Economic Conversion Factors

Table 65 is created to summarize all the estimated economic conversion factors and place them in the same location for further reference. The table follows the same format of the cashflow listing used in the Cashflow Statement from the Banker's Point of View in order to make the linking easy for economic modeling. This table also contains the per item summary of the labor

benefit share in externalities. Having all of these in the standard cashflow listing format helps the analyst to keep the spreadsheet calculations consistent and transparent.

The change in accounts receivable is assigned with the same conversion factor as the feed, assuming that the economic value of the accounts receivable, i.e. deferred payments, is equal to the value of feed consumed right away.

The liquidation values of the plant's assets are given the same conversion factors as their corresponding investment cost items. The land is assumed to be freely traded and because no substantial distortions exist, its conversion factor is equal to one.

The conversion factor for grant, tax, or any other financial transfer is always taken as zero, by definition. The discussion of this issue is presented in Chapter 5 of the *Manual (2003)*. Thus, the stated conversion factors for grant in the revenues and income tax on the expenditure side are zero.

The change in accounts payable is assigned a weighted average CF for the direct operating costs. The conversion factors for the change in cash balances is set to one, implying that this cashflow item is assumed to be non-distorted, i.e. no taxes or subsidies are present.

6.5 Projected Economic Resource Flow Statement

As opposite to the cashflow statement, the economic resource statement operates with flow of real resources rather than financial payments. It does include the economic externalities not captured in the financial cashflows, which are typically generated by the project. The financial revenues in this statement are replaced by a flow of economic benefits, and financial costs are substituted for the flows of economic costs. All the economic flows are always expressed in fixed real prices, reflecting the fact the true economic prices are not affected by inflation. Table VIII below presents the Projected Economic Resource Flow Statement for the feed project, expressed in the prices of year 2002.

6.5.1 Economic Benefits

It is important to model the economic resource statement in a consistent manner with the rest of the spreadsheet. The typical approach is to take the financial cashflow statement from owner's point of view as a basis for the economic statement. The reason for this choice is that the owner's point of view does not include loan items, which are also excluded from the economic statement. Also, it is useful to maintain the uniformity in the listing of the project statements' items.

The mechanics of economic statement modeling is simple once the economic conversion factors for all cashflow items are estimated. The economic values are obtained from the financial cashflows by multiplying them by the estimated conversion factor, i.e. all the annual values of an item are multiplied by the same economic conversion factor:

$$\text{Economic Value}^{\text{Real}}_{\text{ItemM, YearX (Rand}_{2002}/\text{ton)}} = \text{Financial Value}^{\text{Real}}_{\text{ItemM, YearX (Rand}_{2002}/\text{ton)}} * CF_{\text{ItemM}}$$

$$\text{Economic Value}^{\text{Real}}_{\text{Beef Feed, 2003}} = 91,371,705 * 0.99415 = 65,191,821 \text{ Rand}_{2002}/\text{ton}$$

$$\text{Economic Value}^{\text{Real}}_{\text{Beef Feed, 2007}} = 171,047,832 * 0.99415 = 124,529,683 \text{ Rand}_{2002}/\text{ton}$$

The financial value here is referred to the real cashflow statement from the owner's point of view. The underlying assumption is that the economic conversion factor does not change over the project's lifespan. While this assumption may hold for the 10-years life of the feed project, for longer periods this may not be true due to the fact that the tax rates, tariffs and other distortions are likely to change, thus, affecting the conversion factors. The analyst must address this issue when working with a project with a longer lifespan.

Table VIII. Projected Economic Resource Flow Statement: Economy's Point of View, Rand, Real₂₀₀₂.

YEAR:	2002	2003	2004	2005	2006	2007	2008	2009
BENEFITS	Conversion Factor							
Feed Sales	0.99471	0	203,947,634	303,840,353	386,251,846	389,581,603	389,581,603	389,581,603
Total Sales	0	0	203,947,634	303,840,353	386,251,846	389,581,603	389,581,603	389,581,603
Change in A/R	0.99471	0	-7,844,140	-4,286,036	-3,831,154	-968,964	-848,146	-848,146
Change in Feed Inventory	0.99471	0	-12,486,590	125,651	-3,989,426	-848,146	-848,146	-848,146
Liquidation Values	itemized	0	0	0	0	0	0	0
Grant	0.0	0	0	0	0	0	0	0
TOTAL BENEFITS		0	183,616,904	299,679,968	378,431,266	387,764,493	387,885,312	387,885,312
COSTS								
INVESTMENT COSTS								
Land	1.0	1,200,000	0	0	0	0	0	0
Construction	0.79199	29,943,289	0	0	0	0	0	0
Equipment	0.91341	44,936,310	0	0	0	0	0	0
Vehicles	0.78306	350,812	0	0	0	0	0	0
TOTAL INVESTMENT COSTS		76,430,411	0	0	0	0	0	0
OPERATING COSTS								
DIRECT COSTS								
Feed Ingredients	1.02681	16,095,313	222,115,314	283,277,501	347,658,752	347,658,752	347,658,752	347,658,752
Labor	0.67363	0	1,143,851	1,227,950	1,312,861	1,319,425	1,326,023	1,339,316
Electricity	0.96813	0	543,164	754,013	966,725	971,031	975,358	979,707
Water	0.92544	0	222,700	315,555	410,244	414,347	418,490	422,675
Equipment Mechanic Service	0.84764	0	503,991	705,587	907,183	907,183	907,183	907,183
Transportation and Storage	0.86733	0	867,332	1,214,265	1,561,198	1,561,198	1,561,198	1,561,198
TOTAL DIRECT OPERATING COSTS		16,095,313	225,396,351	287,494,870	352,816,963	352,831,936	352,847,004	352,877,428
INDIRECT OPERATING COSTS								
Administration								
Office Accommodation	0.87512	0	525,074	735,103	945,133	945,133	945,133	945,133
Telecommunication	0.87512	0	262,537	367,552	472,566	472,566	472,566	472,566
Advertising	0.84104	0	4,205,221	5,887,309	7,569,397	7,569,397	7,569,397	7,569,397
Audit and Accounting Services	0.79175	0	1,979,377	2,771,128	3,562,878	3,562,878	3,562,878	3,562,878
Business Travel	0.78819	0	394,093	551,730	709,367	709,367	709,367	709,367
Transportation	0.84749	0	635,618	889,865	1,144,112	1,144,112	1,144,112	1,144,112
Office and Transportation Services	0.80906	0	202,264	283,170	364,076	364,076	364,076	364,076
TOTAL INDIRECT OPERATING COSTS		0	8,204,183	11,485,857	14,767,530	14,767,530	14,767,530	14,767,530
TOTAL OPERATING COSTS		16,095,313	233,600,535	298,980,727	367,584,493	367,599,466	367,614,534	367,644,958
Change in A/P	1.0	0	-3,763,648	-1,683,102	-1,783,869	-380,819	-380,842	-380,865
Change in C/B	1.0	0	3,826,141	1,711,049	1,813,489	387,143	387,166	387,213
Corporate Income Tax	0.0	0	0	0	0	0	0	0
TOTAL COSTS		92,525,724	233,663,028	299,008,674	367,614,114	367,605,789	367,620,857	367,651,282
NET RESOURCE FLOW		-92,525,724	-50,046,123	671,294	10,817,152	20,158,704	20,264,454	20,234,029

NPV at 11.0%	-14,459,319
IRR	9.37%

Note that the grant cash inflow is non-existent in terms of flow of real economic resources, and it appears as having zero values. In fact, the grant is a financial transfer from the government to the project and it has no underlying real resource movements.

The total economic benefits are computed each year to sum up all the economic benefit flows. If any positive externality is generated by the project it must be added to the economic benefits. The analyst must identify and quantify any such externalities in order to approximate the true economic impact of the project.

6.5.2 Economic Costs

The economic costs are different from the financial expenditure of the project. The economic costs include any externalities created by the project, and while the cashflow items have been already furnished with a conversion factor, which describes the amount of externality, there could be economic costs not associated with the financial expenditures. For instance, a chemical processing plant may contaminate the project site and pose an environmental danger to the surrounding areas. Even the most advanced pollution abatement methods do not ensure 100% results, and the financial expenses directed on the prevention of such pollution are project's cashflow items but the remaining pollution is not usually accounted and represents a negative economic externality created by the plant.

The modeling of the economic costs flows is identical in its mechanics to the formulation of the economic benefits. The financial expenditures from the banker's cashflow statement are multiplied by the corresponding conversion factors to obtain the economic costs:

$$\text{Economic Value}^{\text{Real}}_{\text{Labor, 2003}} = 1,698,048 * 0.67363 = 1,143,851 \text{ Rand}_{2002/\text{ton}}$$

$$\text{Economic Value}^{\text{Real}}_{\text{Labor, 2007}} = 1,968,482 * 0.67363 = 1,326,023 \text{ Rand}_{2002/\text{ton}}$$

The same procedure applies to all the items in the investment and operating costs. As mentioned above, the conversion factors for the change in cash balances is equal to one, and the conversion factor for corporate income tax is zero. A total of all the economic costs is computed every year.

6.5.3 Economic Net Present Value

The evaluation criteria for this project from the economy's point of view is the net present value, which is based on the net annual economic resource flow and discounted by the economic

opportunity cost of capital (EOCK). The idea is to sum all the annual net resource flows ($\text{NRF}_{\text{YearX}}$) into a single summary measure in order to see if the project is worthwhile for the economy.

Table 66 contains the estimation of the economic NPV. Similarly to the financial NPV, a negative economic net present value will imply a welfare loss for the economy, while a positive net present value will mean that the feed project contributes to the country's well-being. The break-even, zero economic net present value signifies an acceptable project from the economy's point of view, since the project justifies its existence by compensating all the economic costs associated with the re-allocation of resources due to the project. The formula to calculate the economic net present value is:

$$\text{NPV}_{\text{Economy}} = \text{NPV}(\text{EOCK}, \text{NRF}_{2003}^{\text{Real}} : \text{NRF}_{2013}^{\text{Real}}) + \text{NRF}_{2002}^{\text{Real}} = -14,459,319 \text{ Rand}_{2002}$$

The computed economic NPV is a negative figure, which tells the analyst that the project will make the country worse off with its existence. To make the matter severe, remember that the financial NPV is set to zero, i.e. the project just breaks even financially.

The economic internal rate of return is also computed, but it is not considered being an evaluation criteria. The calculated economic IRR of 9.37% shows that the economic performance of the feed plant is far below the economic cost of capital attracted from the other sectors in order to fund this project.

With such a result on hands, further insight into the project's impact on the economy is needed. The distributive analysis will look at the externalities created by the feed project as well as their distribution among the stakeholders of this project.

7. DISTRIBUTIVE ANALYSIS

The distributive analysis looks into the issue of who will benefit from the project and who will bear its costs. Since the National Government has approved a cash grant for this feed project then it is important to identify the beneficiaries of the project to see if this is consistent with the indented policy of promoting the foreign direct investment in Limpopo Province.

The distributive analysis is typically carried out in three consequent steps. First, the project's externalities have to be clearly identified. This task is undertaken in the Statement of Economic Externalities in Section 7.1. Secondly, reconciliation between the financial and economic analysis is necessary in order to ensure an error-free model, and this is done in Section 7.2. Thirdly, an allocation of externalities should be performed to distribute the total generated externality among the stakeholders and Section 7.3 addresses this issue in detail. Finally, the creation of "growth" externalities is examined in Section 7.4.

7.1 Statement of Externalities

The statement of externalities is a statement combining all the project externalities into a single location in order to display the per-item annual externality flows explicitly. According to Chapter 11 of the *Manual (2003)*, the economic externality can be defined as the difference between the financial and economic value, provided that both values are real, inflation adjusted figures:

$$\text{Externality}_{\text{ItemM}} = \text{Economic Value}_{\text{ItemM}} - \text{Financial Value}_{\text{ItemM}}$$

In practical terms, a statement of externalities can be compiled from the Statement of Economic Resource Flows and real Cashflow Statement from the Banker's Point of View. Because the financial cashflows are expressed in real Rand, at the prices of year 2002, and the economic resource flows are also measured in the year-2002 Rand, then the difference between the two will yield the amount of economic externality, valued in the year-2002 Rand. The analyst should link the financial and economic statements by item and by year in order to produce the externality statement. Table IX presents the Projected Externality Flows Statement for the feed project.

Table IX. Projected Externality Flows Statement: Economy's Point of View, Rand, Real₂₀₀₂.

YEAR:	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BENEFITS										
Feed Sales	0	-1,085,187	-1,616,708	-2,055,212	-2,072,929	-2,072,929	-2,072,929	-2,072,929	-2,072,929	-2,072,929
Total Sales	0	-1,085,187	-1,616,708	-2,055,212	-2,072,929	-2,072,929	-2,072,929	-2,072,929	-2,072,929	-2,072,929
Change in A/R	0	41,738	22,806	20,385	5,156	4,513	4,513	4,513	4,513	4,513
Change in Feed Inventory	0	66,440	-669	21,227	4,513	4,513	4,513	4,513	4,513	4,513
Liquidation Values	0	0	0	0	0	0	0	0	0	0
Grant	-1,500,000	-1,415,094	0	0	0	0	0	0	0	0
TOTAL BENEFITS EXTERNALITY	-1,500,000	-2,392,104	-1,594,571	-2,013,599	-2,063,261	-2,063,903	-2,063,903	-2,063,903	-2,063,903	-2,063,903
COSTS										
INVESTMENT COSTS										
Land	0	0	0	0	0	0	0	0	0	0
Construction	-7,864,455	0	0	0	0	0	0	0	0	0
Equipment	-4,260,001	0	0	0	0	0	0	0	0	0
Vehicles	-97,188	0	0	0	0	0	0	0	0	0
TOTAL INVESTMENT COSTS	-12,221,644	0	0	0	0	0	0	0	0	0
OPERATING COSTS										
DIRECT COSTS										
Feed Ingredients	420,313	5,800,314	7,397,501	9,078,752	9,078,752	9,078,752	9,078,752	9,078,752	9,078,752	9,078,752
Labor	0	-554,197	-594,943	-636,083	-639,264	-642,460	-645,672	-648,901	-652,145	-655,406
Electricity	0	-17,880	-24,821	-31,824	-31,965	-32,108	-32,251	-32,395	-32,540	-32,685
Water	0	-17,943	-25,424	-33,053	-33,383	-33,717	-34,054	-34,395	-34,739	-35,086
Equipment Mechanic Service	0	-90,593	-126,830	-163,067	-163,067	-163,067	-163,067	-163,067	-163,067	-163,067
Transportation and Storage	0	-132,668	-185,735	-238,802	-238,802	-238,802	-238,802	-238,802	-238,802	-238,802
TOTAL DIRECT OPERATING COSTS	420,313	4,987,032	6,439,747	7,975,922	7,972,270	7,968,597	7,964,904	7,961,192	7,957,459	7,953,705
INDIRECT OPERATING COSTS										
Administration										
Office Accommodation	0	-74,926	-104,897	-134,867	-134,867	-134,867	-134,867	-134,867	-134,867	-134,867
Telecommunication	0	-37,463	-52,448	-67,434	-67,434	-67,434	-67,434	-67,434	-67,434	-67,434
Advertising	0	-794,779	-1,112,691	-1,430,603	-1,430,603	-1,430,603	-1,430,603	-1,430,603	-1,430,603	-1,430,603
Audit and Accounting Services	0	-520,623	-728,872	-937,122	-937,122	-937,122	-937,122	-937,122	-937,122	-937,122
Business Travel	0	-105,907	-148,270	-190,633	-190,633	-190,633	-190,633	-190,633	-190,633	-190,633
Transportation	0	-114,383	-160,136	-205,889	-205,889	-205,889	-205,889	-205,889	-205,889	-205,889
Office and Transportation Services	0	-47,736	-66,830	-85,924	-85,924	-85,924	-85,924	-85,924	-85,924	-85,924
TOTAL INDIRECT OPERATING COSTS	0	-1,695,817	-2,374,143	-3,052,470	-3,052,470	-3,052,470	-3,052,470	-3,052,470	-3,052,470	-3,052,470
TOTAL OPERATING COSTS	420,313	3,291,216	4,065,604	4,923,452	4,919,800	4,916,127	4,912,435	4,908,722	4,904,989	4,901,235
Change in A/P	0	-84,666	-37,863	-40,129	-8,567	-8,567	-8,568	-8,568	-8,569	-8,569
Change in C/B	0	0	0	0	0	0	0	0	0	0
Corporate Income Tax	0	0	0	0	0	-6,844,729	-8,985,780	-9,256,569	-9,272,191	-9,286,569
TOTAL COSTS EXTERNALITY	-11,801,331	3,206,549	4,027,742	4,883,323	4,911,233	-1,937,170	-4,081,913	-4,356,416	-4,375,771	-4,393,903
NET EXTERNALITY FLOW	10,301,331	-5,598,653	-5,622,312	-6,896,922	-6,974,494	-126,734	2,018,010	2,292,513	2,311,868	2,330,000

NPV at 11.0%	-4,395,172
IRR	40.72%

The listing of items in this statement is identical to the cashflow Statement from Banker's Point of View as well as to the Statement of Economic Resource Flows. Note that items which have conversion factor of one have the value of externality being zero, due to the fact that a unity conversion factor represents undistorted commodities, whose transactions do not generate economic externality. Such undistorted items are the land and the change in cash balances. All the other items have been assigned a conversion factor different from one and, therefore, economic externalities are induced throughout the project life.

The total externalities on the revenue items are computed for each year. The cost-side externalities are also projected into the future, and their net externality flow (NEF_{YearX}) is calculated. The present value of the project's externalities is based on the net externality flow, being discounted by the economic opportunity cost of capital, and it can be found by MS-Excel formula:

$$PV_{Externality} = NPV(EOCK, NEF^{Real}_{2003}:NEF^{Real}_{2013}) + NEF^{Real}_{2002} = -4,395,172 \text{ Rand}_{2002}$$

What the computed result implies is that even the project covers its financial costs, it will cause various stakeholders involved into this project to lose in the economic sense. This negative externality makes the economic NPV go down to -14.5 million Rand₂₀₀₂. Now, it is important to identify the cause(s) of such a negative impact, and allocate the resulting externality to the project's stakeholders.

7.2 Reconciliation between Financial and Economic Analysis

After constructing the Statement of Externalities, the analyst is advised to make a reconciliation between the financial cashflows and economic resource flows to check the internal consistency of the project's model. Given the relationship between the financial and economic values, the following identity must hold true, by definition:

$$\text{Economic Value}_{ItemM} = \text{Financial Value}_{ItemM} + \text{Externality}_{ItemM}$$

Starting with this equation, the analyst can substitute the present values of financial cashflows and externality flows in order to check if their sum is indeed equal to the corresponding present values of economic resource flows. Table 68 shows a typical example of

such reconciliation. For instance, let's check the identity on the example of sales revenues for beef feed:

$$PV^{\text{Economic}}_{\text{ItemM}} = PV^{\text{Financial}}_{\text{ItemM}} + PV^{\text{Externality}}_{\text{ItemM}}$$

$$PV^{\text{Economic}}_{\text{Beef Feed}} = 662,300,722 + (-3,505,392) = 658,795,330 \text{ Rand}_{2002}$$

Note that the present values of the financial cashflows, economic resource flows and externality flows are discounted by the same discount rate, which is the economic opportunity cost of capital, not the financial discount rate. This is important to follow because if the financial discount rate is used, the reconciliation will not work. The analyst must make sure that each and every cashflow item does reconcile, signifying that the model has been built correctly.

Internal Reconciliation

A first cut can be already done on figuring out the main cause(s) for the externalities to be so negative by analyzing the present values of cashflow items. On the benefit side, the negative externality from the feed sales dominates the flows with about -11.0 million Rand₂₀₀₂ out of the total benefits externality of -15.7 million Rand₂₀₀₂. On the cost side, there is no single item winning the control over the net -11.3 million Rand₂₀₀₂ costs externalities, but the most prominent items are the foreign exchange cost of the feed ingredients (49 million Rand₂₀₀₂), corporate income tax (-25.6 million Rand₂₀₀₂), total investment costs (-12.2 million Rand₂₀₀₂). The difference between the PV of benefits externalities and PV of costs externalities is the PV of the total net externalities:

$$PV_{\text{Externality}} = -15,659,635 + (-11,264,463) = -4,395,172 \text{ Rand}_{2002}$$

Looking at the magnitude of the figures in the externalities column of Table 68, the analyst may notice that the big amount of externalities are generated by the following items: the feed sales, investment costs, cost of feed ingredients, indirect operating costs, and corporate income tax. Before an allocation of the estimated externalities is made to the project's stakeholders, let's examine the forces that stay behind each of the identified group with sizeable externalities.

The feed sales externalities are generated by the distortions in the feed inputs and consist of forex savings on the feed ingredients and foregone taxes, tariffs and labor externalities in the production of feed by other producers. The externalities in the investment costs are primarily caused by the foreign exchange premium and also by a creation of externality for labor. The externalities in the cost of feed ingredients, as Section 6.4.18 explained, are caused by the foreign exchange premium too. The items of the indirect operating costs have conversion factors less than one, and the wedge between the financial and economic values is driven by the forex

premium and labor externalities. The corporate income tax is a pure transfer on the National Government's behalf.

7.3 Allocation of Economic Externalities

Any project affects a number of parties, either involved directly into the project or influenced by it indirectly, and it is important to identify the main stakeholders affected by the project. The issue here is to identify the gainers and losers from the project, and allocate the estimated externality amongst the stakeholders. Remember that the financial return has been already ensured by using the discount rate equal to the minimum acceptable rate of return on investment, which means that the owners of the factors of production have been provided with the minimum required financial reward for the employment of their resources. Therefore, only the project's externalities must be allocated to the affected parties but not the actual financial payments, since all the payments have been already accounted for.

It is also important to understand that the externalities do not accrue to the project itself since all the financial costs are already included into the evaluation, while other parties may either lose or gain due to the project. Thus, the project analyst should exclude the project from being a stakeholder in the distributive analysis and, instead, should allocate all the estimated externalities to the affected parties.

The identification of the project's stakeholders can be another hurdle on the way of the analyst. A typical project evaluation refers to, at least, two stakeholders: government and labor. In fact, there can be many stakeholders affected by the project and such stakeholders as the environment, project's suppliers, consumers, project's competitors are often listed in investment appraisal studies. The main criteria for distinguishing a stakeholder as having unique characteristics to separate the externalities accruing to this particular stakeholder in a clear and consistent manner. For instance, if the environmental impact is quantified, then the environment can be treated as a "stakeholder" affected by the project. For more generic fiscal impacts such as taxes, tariffs, subsidies, grants, and alike, the government is usually nominated into the position of stakeholder standing to gain or lose from these externalities.

For the feed project in question, two stakeholders are considered in the distributive analysis: labor and government. Both possess the required degree of detail to distinguish its own externality from the total pool of generated externalities. In fact, only the labor externalities need

to be separated because the government is assumed to receive the remaining amount of total externalities. Table 69 represents the Allocation of Externalities among the project's stakeholders.

Externalities: This column contains the present values of all the externality flows, so that the project analyst can allocate all, or just a portion, of this value to the identified stakeholders. Because the same item listing order has been kept in the model it is easy to navigate through it. The total present value of externalities is found as $-4,395,172 \text{ Rand}_{2002}$.

Labor: The purpose of this column is to quantify the amount of labor externality per item. The term "labor" here refers to all the three labor types combined into a single stakeholder. Note that it is based on the computed share of labor benefits in the externality, calculated in the Sections 6.3.1–6.3.3 and summarized in Table 65. The amount of labor externality for any item M is simply the product of its labor benefits share and the present value of externalities for the item:

$$\begin{aligned} \text{Labor Externality}_{\text{ItemM}} &= \text{Labor Benefits Share}_{\text{ItemM}} * \text{PV}^{\text{Externality}}_{\text{ItemM}} \\ \text{Labor Externality}_{\text{Labor}} &= 62.0\% * -3,678,543 = -2,279,934 \text{ Rand}_{2002} \\ \text{Labor Externality}_{\text{Equipment Mechanic Service}} &= 27.0\% * -865,638 = -234,039 \text{ Rand}_{2002} \end{aligned}$$

Referring back to Table 65, many cashflow items don't actually have any labor externality and they are set to zero. Now, the calculation of labor externality is based on these shares and any item having a zero share turns out to have a zero labor externality allocation in Table 65. The total allocation of externalities to labor amounts to $4,648,522 \text{ Rand}_{2002}$.

Government: The National Government is assumed to inherit all the remaining externalities after deductions to the labor have been made. The total net amount of externality accruing to the National Government is $-9,043,694 \text{ Rand}_{2002}$, and it is important to look at the composition of this negative externality. The revenue side has a PV of the externality equal to $-15,028,531 \text{ Rand}_{2002}$, caused by the negative externality on the feed sales.

The costs side of the government externalities shows more variety in results. Thus, the government collects taxes on the investment costs items ($12,209,689 \text{ Rand}_{2002}$) as well as taxes on the indirect operating costs items ($13,514,348 \text{ Rand}_{2002}$) and corporate income tax ($31,467,184 \text{ Rand}_{2002}$). But the Government suffers a loss of foreign exchange due to the overall increased consumption of feed ingredients, and the direct cost section amounts to a net externality of $35,388,355 \text{ Rand}_{2002}$. The Government also collects corporate income taxes from the project worth $25,592,658 \text{ Rand}_{2002}$ in the present value. The resulting total of the cost-side is $-6,048,935$

Rand₂₀₀₂. Note that because the project's cost items are negative flows for the project, they become positive inflows to the Government.

The difference between the PV of benefits-side externalities and PV of cost-side externalities is the present value of net externalities, and it is found as -4,395,172 Rand₂₀₀₂, which is exactly the amount of externality computed in Tables 67 and 68. All the computed figures do reconcile, implying that the model has been built correctly and no mechanical errors were made.

7.4 Growth Externalities vs. Net Externalities

The distributive analysis can be further expanded by examining the impact on of the project on the “growth” externalities, and Table 70 presents the findings of this evaluation. The feed project is assumed to generate a rate of return on private investment equal to the weighted average cost of capital (WACC), so that the owner gets compensated for the opportunity cost of his capital. Since the economic opportunity cost of capital in South Africa is 11.0% then the average real return from the projects in the country is the estimated 11.0% rate. The difference between the private WACC rate and economic EOCK rate entails a cost to the economic because this capital, whether public or privately-owned, could have been invested into another sector with the average return of 11.0%, in real terms. The cost is measured by “growth” externalities, typically created by forgone tax and tariff collections, premium/loss on the foreign exchange transactions, cost of inter-industry resource transfer and so on.

Net Cash Flow from Banker's Point of View: The feed project is owned and financed, for the most part, by a foreign investor, who does not cause a withdrawal of domestic capital from other sectors, and the feed plant is not an incremental investment in this respect because the source of funds is external to the economy. The foreign investor requires a 10.0% minimum rate of return on investment (ROI), in real terms. The loan borrowed from a local bank carries a real interest rate of 8.5%. Then, the WACC must be a rate between the 10.0% ROI and 8.5% interest rate.

To make the computation of WACC easier, the analyst should remember that the WACC, used as the discount rate in the computation of the NPV from the total investment's (banker's) point of view, will make that NPV equal to zero. Therefore, the rate of WACC can be found by using the “Goal Seek” function of MS-Excel by setting the NPV of net cash flow from banker's

point of view (NPV_{WACC}^F) to zero through changing the discount rate. The resulting rate of 9.85% ensures the break-even of the banker's NPV.

Note that the net cashflow is taken directly from Table 14. The same financial cashflow can be discounted by the economic discount rate. If the net cash flow from banker's point of view is discounted by the EOCC, then an NPV of $-10,064,147 \text{ Rand}_{2002}$ is obtained. This is net present value of the financial flows discounted at the economic discount rate (NPV_{EOCC}^F).

Net Resource Flow from Economy's Point of View: The net worth of the feed project from the economy's point of view is the net present value (NPV_{EOCC}^E) of the economic resource flows associated with the project. The calculation of the economic NPV is identical to the procedure described in Section 6.5.3. The economic net resource flow is taken directly from Table 66. The resulting NPV is $-14,459,319 \text{ Rand}_{2002}$.

Net Externalities Flow from Economy's Point of View: The present value of economic externalities (PV_{EOCC}^{Ext}) generated by the project can be estimated based on the net externalities flow taken from Table 67. Section 7.1 has already discussed the computation of this present value as $-4,395,172 \text{ Rand}_{2002}$.

Reconciliation: The net economic impact of the project should be equal to the project's financial impact from the total investment's point of view plus the total externalities generated in the economy and plus the capital market net impact, which is the difference between the project's financial NPVs discounted by the economic and private discount rates:

$$NPV_{EOCC}^{Econ} = NPV_{WACC}^{Fin} + PV_{EOCC}^{Ext} + NPV_{EOCC}^{Fin} - NPV_{WACC}^{Fin}$$

$$0 + [-4,395,172] + [-10,064,147] - 0 = -14,459,319 \text{ Rand}_{2002}$$

In the above equation, the NPV from the total investment perspective is zero signifying the fact that the feed plant breaks even financially. The net growth externalities can be approximated by the difference between the project's financial NPV at the economic opportunity cost of capital and financial NPV at the private discount rate (WACC):

$$\text{Net Impact on Capital Market} = NPV_{EOCC}^{Fin} - NPV_{WACC}^{Fin}$$

$$\text{Net Impact on Capital Market} = [-10,064,147] - 0 = -10,064,147 \text{ Rand}_{2002}$$

Because the underlying assumption was that the project does break even financially, the NPV from the total investment perspective is zero, and the resulting net externalities are identical to the present value of total externalities.

But this figure really measures the net effect on the tax collections and capital allocation. The negative amount of net growth externalities here signifies a damaging impact on the economy through lost taxes, tariffs and forex premium that would have been generated if the capital was invested into a project where it would make the 11.0% return.

7.5 Economic and Distributive Sensitivity Analysis

Having built the complete financial and economic model of the project, it is useful to look at the responsiveness of the model to changes in its parameters, and this section deals with this task for the economic and distributive modules, done in a similar manner as it was for the model's financial module. The idea is to test the impact of a single parameter on the economic and distributive outcomes by the means of re-calculating the model with different values of the parameter in question. Again, the model's response to the parameter is labeled as "high", "medium", "low" and "none".

For the economic and distributive sensitivity analysis, a different set of project's indicators is used. Because the financial NPV and debt service ratios do not represent the economic resource flows they are excluded and, instead, the following indicators are employed: NPV of the Economic Resource Flows Statement, total PV of the Statement of Externalities, PV of Labor Externalities, and PV of Government Externalities. The economic NPV measures the economic outcome of the project, while the total PV of Externalities shows the net amount of total externalities generated by the project. The PVs of labor and government externalities are included here to show the impact of a change in the tested parameter on each stakeholder.

In regard to the selection of parameters for the sensitivity test, it should be noted that not all parameters examined in the financial sensitivity analysis are eligible for the economic sensitivity test, because some of them are purely financial variables not affecting the real economic fundamentals.

7.5.1 Change in Cost of Feed Ingredients

This parameter is tested in the economic sensitivity analysis with the same range of variation from -25% to +25% with an increment of 5%. Table 71 shows the results of the sensitivity test in a tabular form, and the analyst can mark this parameter's impact on the model as "high". The economic NPV, PV of total externalities, PV of labor externalities and PV of government

externalities are all negatively related with the change in the cost of ingredients. Thus, if the cost of feed ingredients is to rise, the impact would induce a deterioration of the economic NPV and a decline in the positive externalities generated by the project.

7.5.2 *Change in Milling Fee*

The economic sensitivity test, results of which presented in Table 72, reveals that the model is “highly” sensitive to this parameter. The economic NPV, PV of total externalities, and PV of government externalities are positively linked with the change in the milling fee, but the PV of labor externalities show a negative relationship with this parameter. This means that if the change in the cost of milling is positive, then there is an increase in the values of economic NPV, total externalities, and government’s externalities, but there is a decline in the amount of the labor externalities. The negative relationship with the PV of labor externalities is explained by the fact that the labor externality in the items is dependent on the actual capacity utilization, and labor externality is reduced by a higher milling fee through the demand mechanism, affecting the production schedule and operating costs.

7.5.3 *Domestic Inflation Rate, 2003-2013*

This sensitivity test shows the response of the economic module of the project to the different average inflation rates, ranging from 0% to 10% in increment of 1%. Table 73 presents the results of this sensitivity test, which allows us to characterize this variable as being a “medium” sensitive parameter. This result is somewhat different from the financial impact of the inflation rate, which was labeled “high”. The economic NPV, PV of total externalities, and PV of government externalities are negatively correlated with the domestic inflation rate, while the PV of labor externalities is not dependent on this parameter.

7.5.4 *Disturbance to Real Exchange Rate, 2002-2013*

The impact of this parameter on the economic and distributive outcomes of the project is tested under the same $\pm 50\%$ range of disturbance to the real exchange rate. The model appears to be “highly” sensitive to this parameter, as shown in Table 74. A positive disturbance to the real exchange rate reduces the economic NPV but, at the same time, causes all externalities to rise.

7.5.5 Tax Holidays

The length of tax holidays will directly impact on the size of the total externalities and the Government's share of them. Table 75 displays the results of the test, which confirm the “high” sensitivity of the model to this parameter. A longer duration of tax holidays will definitely improve the project's economic NPV but that will happen on the expense of the total externalities and Government's externalities. The present value of labor externalities is insensitive to the duration of tax holidays.

7.5.6 Investment Cost Overrun Factor

The investment cost overrun factor affects only the amount of local construction costs, and its impact on the project's performance is not expected to be crucial from the economic perspective. Table 76 confirms that expectation. The economic NPV and PV of labor externalities are negatively related with the investment cost overruns, but the PV of total externalities and PV of government externalities reveal a positive relationship with this parameter. Thus, if the investment cost overruns increase, the impact would include a deterioration of the economic NPV and PV of labor externalities, while the total externalities and government's externalities would increase. The positive relationship of the PV of total externalities and PV of government externalities is explained by the fact that the Government will collect taxes on the construction activities. The overall sensitivity of the model to this parameter is “medium”.

7.5.7 Composite Demand Elasticity for Meat

Following the financial evaluation, the economic sensitivity analysis puts this parameter under test to find out the degree of the model's dependence on this variable. Table 77 shows the result of the sensitivity test, with an obvious negative relationship of this parameter with the economic NPV, PV of total externalities and PV of government's externalities. The PV of labor externalities is not influenced by changes in this variable. The overall model's sensitivity to this parameter is “low”.

7.5.8 *Supply Elasticity of Feed by Others*

The supply elasticity of feed by other manufacturers deserves being tested for its impact on the economic module of the project's model, and the results of this test are presented in Table 78. The relationship between this parameter and economic outcomes are such that the economic NPV, PV of total externalities and PV of government's externalities are negatively linked to the supply elasticity of feed by others, i.e. a higher elasticity results in a lower economic NPV. The present value of labor externalities is not related to changes in the feed supply elasticity by other manufacturers. The overall impact of this parameter is "low".

8. RISK ANALYSIS

Up to now an integrated financial and economic model of the feed project has been built based on the assumptions of various parameters, and the results of the model are nothing else as a unique combination of the proposed parameters. The issue is whether the parameters used in the deterministic model, completed so far, really remain constant over the project's lifespan. The obvious answer is that most of the parameters will be either more or less than the used values, but not exactly the same what is actually used in the model.

The sensitivity analysis has already addressed the need to identify the importance of the project parameters, but the method of the sensitivity analysis falls short of assigning a probability to the tested values in the parameter. For example, the probability of a little deviation from the trend of the real cost of feed ingredients in a certain year is higher than the probability of a great deviation from the trend. The sensitivity analysis is not equipped to test the project for such changes while the risk analysis is able to handle this task.

The risk analysis allows the analyst to see what will be the likely effect of the interaction of the various variables affecting the outcomes of the project. A risk simulation is carried out in order to assess the sources and nature of the variability of the resulting financial and economic water costs as well as the economic net present value of the project.⁵ A few steps are prerequisite to running a simulation: a set of "input" risk variables has to be defined and assigned a reasonable probability distribution for each variable; then the relationships among the risk variables have to be specified; and the targeted "output" variables have to be selected.

Thus, Section 8.1 is devoted to the selection of the risk variables, which are chosen from the parameters tested in the sensitivity analysis, and to the selection of an appropriate probability distribution for each risk variable. The results of the risk analysis are discussed in Section 8.2.

8.1 Selection of Risk Variables and Probability Distributions

Not all the parameters tested in the sensitivity analysis are worth being included into the risk analysis. The ones that are truly eligible to be risk variables typically possess two traits: the model is very sensitive to this parameter and there is a great deal of uncertainty over the exact

⁵ A comprehensive description of the process of preparation and running a risk simulation with the Crystal Ball® software is described in Decisioneering, Inc. (2000).

value of the parameter in question. If a parameter lacks either of these two characteristics, the project analysts should reconsider the introduction of this parameter to the risk analysis.

If the project's model is not sensitive to a parameter then it is not worth analyzing its impact on the project in the risk analysis because the sensitivity analysis already estimated the strength and direction of the relationship between this parameter and project's outcomes. At the same time, if the parameter has a strong impact on the project's outcome but its future value is certain and predictable, then it does not make sense to model this parameter into the risk analysis.

Amongst the parameters already tested in the sensitivity analysis only four qualify to be selected as risk variables in the risk analysis. The chosen parameters are the annual disturbances to the domestic inflation rate, foreign real exchange rate, cost of feed ingredients, and the investment costs overrun factor.

The first three risk variables are the annual disturbance to the corresponding parameters, which were set to zero in the spreadsheet during the financial and economic analysis. They are to be simulated annually, being assigned a different value in each year. The investment costs overrun factor is rather a one-time risk variable, which does not recur annually. It was also set to zero in the financial analysis. The next sections are devoted to developing an appropriate probability distribution for each of the selected risk variables.

8.1.1 Disturbance to South African Annual Inflation Rate

The annual inflation rate is one of the macro-economic variables that are very difficult to predict given the complexity of economic, financial and political forces influencing its determination. Its annual movements are hardly predictable and because the model's sensitivity to this parameter was also "high", the domestic inflation rate does qualify to be included into the risk analysis.

Once a decision is made whether to include a parameter as a risk variable, an appropriate probability distribution must be assigned to it. Unfortunately, the analyst will find just few cases when the risk probability distributions are readily available for the project analysis. The typical situation that the analyst faces is the need to derive a probability distribution from the raw historical data on the variable in question. Table 79 presents the derivation of a probability distribution for the disturbance to the annual domestic inflation rate from the 1971-1999 historical data on its movements, published by the IMF (2000).

Raw Data: Thus, the first two columns show the average annual inflation rate of the South African Rand from 1971 to 1999. What is needed to do now is to carry out a regression on the average annual inflation rate in order to separate the “predicted” inflation rate and “residual”, or unexplained, inflation rate. While complex regression procedures can be successfully employed here to mathematically model the actual behavior of the inflation rate, such a task can be reasonably well by using a simple linear regression. The analyst has the choice whether to use a more advanced formulation of the inflation rate behavior or to stay with the simple and appealing method of the linear regression.

Predicted and Residual Values: The regression can be carried in MS-Excel by using the in-built “regression” function, which generates two columns of output: “predicted” values and “residual” values. The predicted values show the trend value of the domestic inflation rate “explained” by the regression, which can be also called “expected” inflation rate. But because of the unpredictable nature of the inflation rate movements, the actual historical values are typically do not match their regression-predicted values and there is some amount of unexplained inflation, called the “residual” value. This residual value really represents the risky unpredictable component of the annual inflation rate movement.

By definition, the sum of the predicted inflation rate and residual inflation rate is equal to the actual rate of inflation, for instance the record for the South African inflation rate in 1971 confirms that the actual 7.41% rate is equal to the sum of its predicted rate of 12.42% and a residual of –5.01%. Thus, the column with the residual values contains the annual unexplained deviation of the actual rate of inflation from its predicted trend.

Deviation from Predicted Value: The next step is to express the residual amount of divergence as a percentage deviation from the predicted value. In other words, the predicted value in each year is treated as 100% of what the inflation rate “should” be, and the residual value is expressed as a percentage of that amount by using a formula:

$$\begin{aligned}\% \text{ Deviation}_{\text{YearX}} &= \text{Residual}_{\text{YearX}} / (\text{Predicted}_{\text{YearX}} / 100) / 100 \\ \% \text{ Deviation}_{1971} &= -5.01\% / (12.42\% / 100) / 100 = -40.35\%\end{aligned}$$

In other words, there is a 40% negative deviation of the actual inflation rate from its predicted trend value. This huge annual divergence between the predicted and actual inflation rates is not explained by the regression, and represents the risk factors at work. Having completed the computation of the percentage deviation for all the historical data records, the analyst has a list of risk-related deviations of the parameter over a number of years.

Sorted Deviation: Since the computed percentage deviations still correspond to the respective data records, the analyst should break this dependence and consider the percentage deviations being a sample of the risk movements of this variable, independent from the original data records. This sample set should be sorted from the lowest deviation to the highest in order to see the range of risk movements of this parameter. The MS-Excel has a special function, called “Sort”, to help the analyst making a list of percentage deviations in the ascending order. The column named “sorted percentage deviations” contains the results of this procedure.

It becomes apparent that the risk movement in the annual South African inflation rate over 1971-1999 ranges from –58.17% to +58.35%. This means that, in any given year, the actual inflation rate may fluctuate around its predicted trend value by about $\pm 60\%$ annually, which indeed represents a substantial variation.

Unadjusted Probability Distribution: The probability distribution is simply a set of ranges of variation of the parameter values with a probability assigned to each range. For instance, the whole range from –60% to +60% deviation of the annual inflation rate can be broken into 11 brackets with a 10%-wide variation. The midpoint of each bracket is immediately computed. The analyst has the freedom of selection for the brackets and their width. However, it is important to select such intervals that each bracket has, at least, one observation in it in order to be representative.

Now, the analyst should count the frequency of occurrence in each bracket, which counts the number of observations inside each interval. For instance, the bracket from –60% to –50% has two observations out of the total of 29 historical observations and, therefore, the percentage share of this bracket is 6.9%, which is 2 over 29. Note that the frequency count should always add up to the total number of observations, and the sum of percentage shares must be equal to 100%, by definition. Thus, the unadjusted probability distribution is the set of chosen brackets and a probability of occurrence of each bracket.

Unadjusted Expected Value: The legitimate question at this point would be about the acceptance criteria of a probability distribution, which has just been derived from the raw data of inflation rate movements over 1971-1999. An acceptance probability distribution is such that has its “expected value” equal to zero. As a matter of fact, the expected value of a probability distribution is the weighted average of the midpoints of the chosen brackets, or:

$$\text{Expected Value} = \sum_M (\text{MidPoint}_{\text{BracketM}} * \text{Probability}_{\text{BracketM}})$$

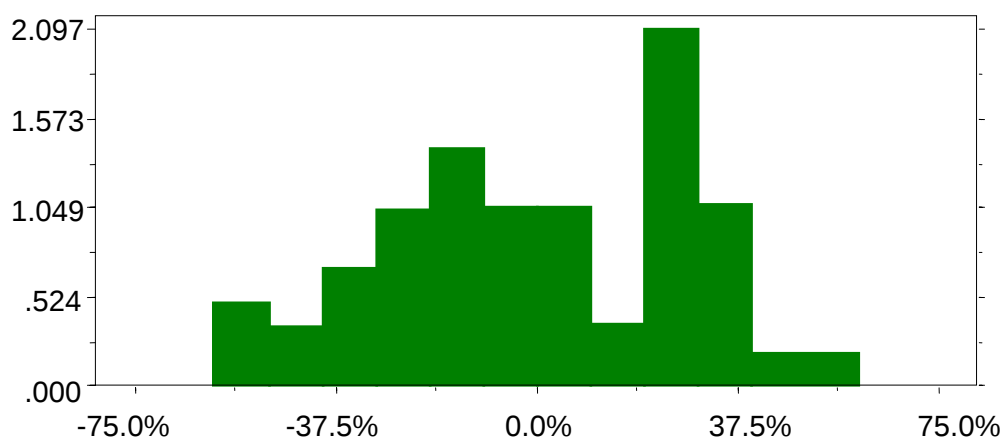
If the expected value is different from zero then the probability distribution is biased either upward or downwards and such a probability distribution can not be used for the risk analysis. An adjustment is needed to bring the expected value of the distribution to zero.

Adjusted Probability Distribution: As stems from the previous formula, the expected value can be adjusted either by changing the mid-points of the chosen brackets or/and by changing the probability of occurrence assigned to each bracket. Because a change in the mid-points would impact on the brackets structure, it is recommended to use the second route, which is to correct the frequency of occurrence so that it is still equal to their present total and also makes the expected value equal to zero. In other words, the existing column with frequency of occurrence must be modified so that its total still remains 29 but the expected value is equal to zero.

The analyst should be aware that it is very difficult to execute this modification by hand computations because it involves solving a set of simultaneous equations subject to the constraint of the total being equal to 29. Instead, a built-in MS-Excel function is used, called “Solver”, which adjusts the frequency of occurrence cells so that the problem constraints are honored, and the desired expected value is finally obtained. The solver maintains the general proportions of the original unadjusted probability distribution by applying a complex mathematical method.

As Table 79 demonstrates, the adjusted probability distribution differs from the unadjusted distribution by the frequency of occurrence. The resulting expected value is zero, and the analyst can use the derived brackets with their probability of occurrence to model the risk behavior of the disturbance to the annual inflation rate. Graphically, the derived probability distribution can be depicted as in Figure V.

Figure IV. Probability Distribution of Disturbance to Annual Domestic Inflation Rate.



This probability distribution can be readily used in the project spreadsheet, by applying it on the disturbance to the annual domestic inflation rate in the Schedule of Inflation Rates, Price

Indices and Exchange Rate. Note that this probability distribution can not be applied directly on the annual inflation rate because it is rather expressed in terms of deviation from the expected inflation rate. This way of modeling allows the analyst to be flexible to incorporate both the expected trend of the variable as well as unexpected risk fluctuation around the trend:

$$i_{YearX}^D = i_{Expected, YearX}^D * (1 + \text{Disturbance to SA Inflation Rate}_{YearX})$$

Thus, annual inflation rate in year X is determined by the expected inflation rate and the disturbance to it, to be generated during the risk simulation from the assigned probability distribution.

8.1.2 *Disturbance to South African Real Foreign Exchange Rate*

The importance of this parameter has been marked as “high” in the sensitivity analysis and because it is also fluctuates in an unpredictable manner from year to year; it becomes a candidate for the risk analysis. The probability distribution of the foreign exchange rate movements can be derived from the residuals of a regression made on the real exchange rate. Similarly to the derivation of the probability distribution for the inflation rate, the procedure here starts with a set of raw data, obtained from IMF (2000), which contains a historical record of the average annual nominal exchange rate (Rand/US\$) from 1970 to 1999. The same publication is the source of the data for the South African consumer price index (CPI) during 1970-1999. Table 80 shows the derivation of a probability distribution for the disturbance to South African real foreign exchange rate.

Nominal vs. Real Exchange Rate: Most often the data on the exchange rates are stated in their nominal form, rather than in real, and an additional transformation is needed to convert the nominal exchange rates into the real rates, expressed in the same price level. This transformation can be done through applying the following formula:

$$E_{YearX}^{Real} = E_{YearX}^{Nominal} * PI_{YearX}^{World} / CPI_{YearX}^{South\ Africa}$$

Where the real average exchange rate in year X is found as the nominal average exchange rate (E^{Real}) multiplied by the world price index (PI^{World}) and then divided by the domestic consumer price index ($CPI^{South\ Africa}$). While the nominal exchange rate and domestic price index are usually available in the country macro-economic data, the world price index has to be estimated by the analyst. The world price index used here was estimated by the Cambridge Resources International and was based on the 1970-1999 forex data of the US dollar, UK pound,

German mark, French frank, Japanese yen, and SDR. The actual estimation of the world price index is somewhat outside of the scope of this study and only the results of it are presented in the column with the world price index. Thus, the average real foreign exchange rate for any year can be estimated by:

$$E_{1970}^{\text{Real}} = E_{1970}^{\text{Nominal}} * PI_{1970}^{\text{World}} / CPI_{1970}^{\text{South Africa}}$$

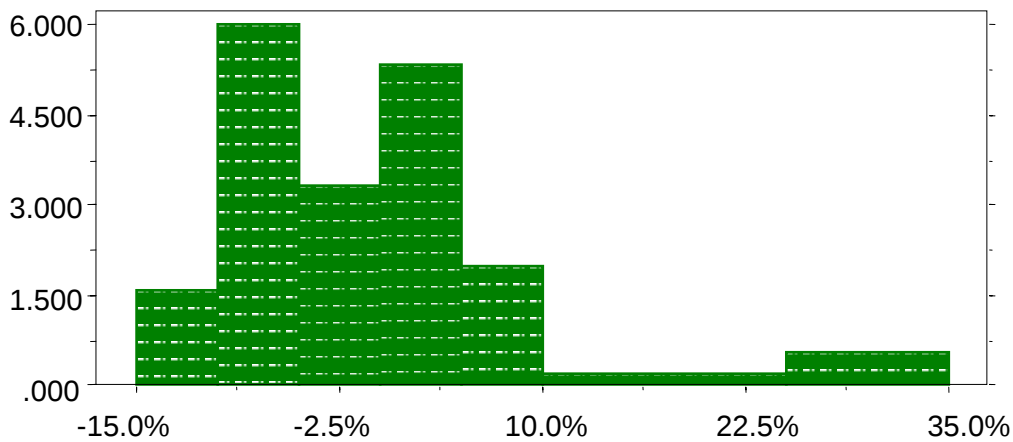
$$E_{1970}^{\text{Real}} = 0.71429 * 21.56 / 5.4 = 2.85 \text{ Rand/US\$}$$

Regression and Percentage Deviations: A simple linear regression is run on the resulting average real foreign exchange rate, and predicted as well as residual values are obtained for each observation. The percentage deviations of the actual real exchange rate from the predicted rate are computed in the same way as was explained in Section 8.1.1.

The column with percentage deviations is consequently sorted in the ascending order from its lowest value to the highest. The resulting new column with sorted percentage deviations shows a range of historical unexplained annual foreign exchange rate fluctuation from –13% to +33%, which leads to the selection of seven brackets with an interval of 5%.

Adjusted Probability Distribution: Given the choice of the brackets and range of the exchange rate historical movements, a frequency of occurrence is assigned to each bracket and probability of occurrence is computed based on a total of 30 observations. The unadjusted expected value is not equal to zero and a procedure, identical to the one done in Section 8.1.1, is performed here in order to obtain zero in the expected value of this probability distribution. The resulting adjusted probability distribution is graphically demonstrated in Figure VI.

Figure V. Probability Distribution of Disturbance to South African Real Foreign Exchange Rate.



The analyst can use this probability distribution, but it is important to make sure that it is integrated into the model in the correct way. This risk distribution can not be applied directly on the foreign exchange rate and, instead, it should be modeled on the disturbance to the real exchange rate in the Schedule of Inflation Rates, Price Indices and Exchange Rate, as was already discussed in Section 5.3.3:

$$E_{Adj}^{Nominal}_{YearX} = E_{Unadj}^{Nominal}_{YearX} * (1 + \text{Disturbance to Real Exchange Rate}_{YearX})$$

If the above modeling requirement is implemented right, the adjusted nominal exchange rate projection will feature the ability to have a long-term trend as well as the flexibility of annual fluctuations due to the changes in the disturbance factor.

8.1.3 Disturbance to Cost of Feed Ingredients

The financial and economic sensitivity analysis has already asserted the “high” importance of this parameter on the project, and this coupled with the seasonal price fluctuation of agricultural commodities, allows the analyst to include this parameter into the risk analysis. Once again, the issue is to select an appropriate probability distribution for this variable.

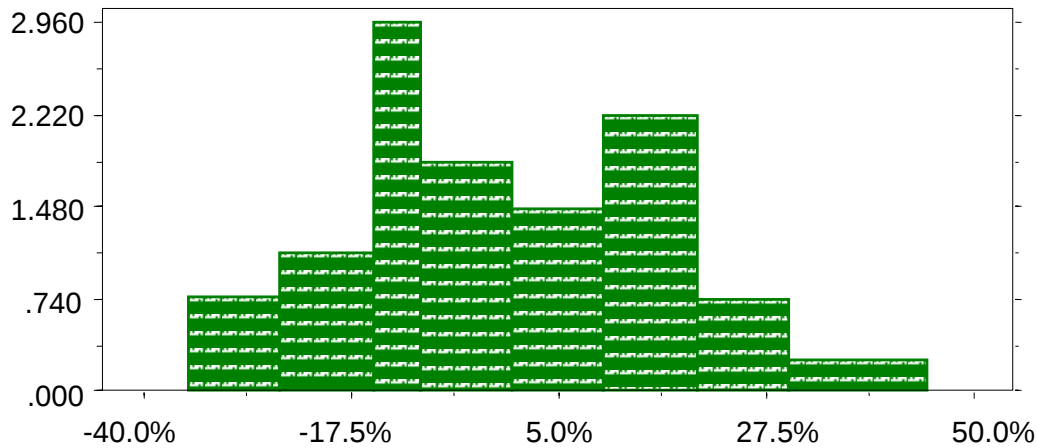
As noted earlier, the feed ingredients may include so many components that it is deemed useless to try modeling them separately. Largely to this problem, the model was based on the average cost of a feed ingredients mix that, in fact, consists of many components which can be purchased separately from others. In other words, each component of the feed ingredients mix has its own price trend and a unique set of supply and demand factors determining its market price. It would make no sense to attempt modeling all individual ingredients into the risk analysis.

A practical solution to this problem is offered by the fact that most of the feed ingredients prices move together with the international price of maize and while their individual prices differ substantially, the unexplained movements are very close to each other. Therefore, the unexplained maize price movements can be used as a proxy for the risk distribution for the feed ingredients. This sound and verifiable assumption makes the following work easy, since the historical data on the maize prices are available for a number of years. The data set used here was obtained from the FAO (1997), covering a period from 1970 to 1996. Table 81 shows the derivation of the probability distribution for the disturbance to the cost of feed ingredients.

Nominal vs. Real Maize Prices: The first columns contain the annual observations of the average yellow maize price delivered to the Maize Board in South Africa, and expressed in nominal US dollars. These prices have to be converted into the real prices through dividing them by the US producer price index, which was taken from the IMF [2000]. The resulting real average yellow maize prices are expressed in the constant 1995 dollars, and can be used in a regression.

Adjusted Probability Distribution: The mechanics of derivation of the adjusted probability distribution for this parameter is the same as already demonstrated in the two preceding sections, and its results are presented in Table 81. The adjusted probability distribution for disturbance to cost of feed ingredients is graphically illustrated in Figure VII.

Figure VI. Probability Distribution of Disturbance to Cost of Feed Ingredients.



Once again, it should be noted that the correct way of introducing this parameter into the model is to apply the derived probability distribution on the disturbance factor in the Schedule of Feed Ingredients Costs and Feed Prices:

$$C_{Adj}^{Nominal}_{YearX} = C_{Unadj}^{Nominal}_{YearX} * (1 + \text{Disturbance Factor}_{YearX})$$

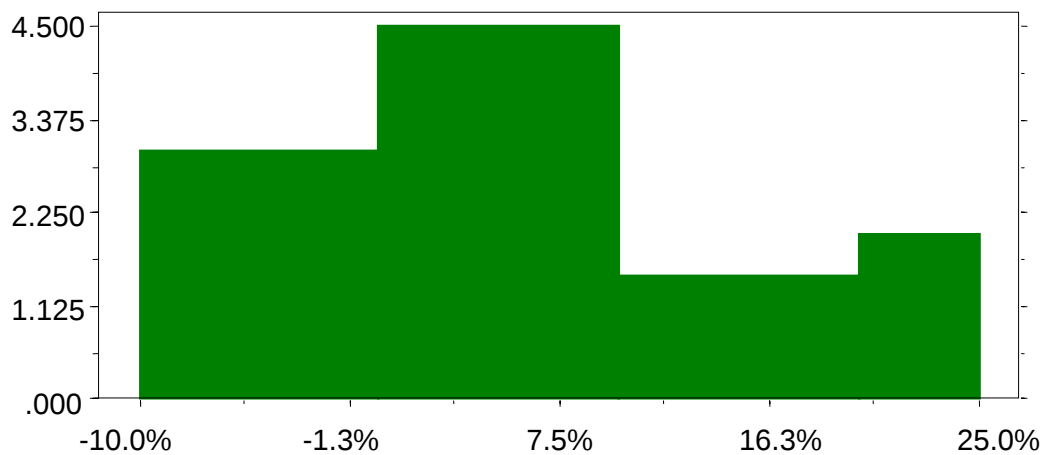
Thus, the adjusted nominal cost of feed ingredients in a certain year is a product of the unadjusted nominal cost of feed ingredients and the annual disturbance factor, to be generated during the risk simulation. The resulting adjusted nominal cost has both elements of the long-run trend as well as an annual fluctuation around that trend.

8.1.4 Investment Cost Overrun Factor

Although the sensitivity analysis marked the feed plant model's responsiveness to this parameter as "medium", it has been a common practice to include this parameter into the risk analysis because of its uncertainty. Following this reasoning, the probability distribution for this parameter was adopted from the Department of Water Affairs and Forestry, which has built this probability distribution on its past experience with civil works projects in South Africa.

The probability distribution adopted here has four brackets: -10% to 0% with 30% likelihood, 0% to 10% with 45% likelihood, 10% to 20% with 15% likelihood, and 20% to 25% with 10% likelihood. The graphical representation of this distribution is given in Figure VIII.

Figure VII. Probability Distribution of Cost Overrun Factor.



As already discussed in Section 5.2.15, the cost overrun factor is not actually applied on the equipment, land, installation and mounting expenses. But where it is applied, the following modeling method is needed in order to integrate the parameter correctly:

$$C_{2002} = C_{2001} * (1 + i^D_{2001}) * (1 + \text{Investment Cost Overrun Factor})$$

Then, the estimated cost of a construction item in year 2002 is based on the cost of year 2001, with an integrated adjustment for the inflation and for any unexpected cost overrun. Section 5.4 has explained which investment cost items should be modeled with the cost overrun factor.

8.2 Results of Risk Analysis

A Monte-Carlo simulation was performed with 10,000 runs. With each run a set of the “input” variables was generated from their assigned probability distributions, and results of the “forecasts” were recorded. The outcomes of the simulation can be described using a set of simple statistics: mean, standard deviation, minimum and maximum values.

The mean of a set of outcomes is the expected value of the variable on which the risk analysis is performed. If the mean of the simulated outcomes is too biased from the original “static” value of the variable - then it tells us about a tendency that, in reality, the value of the variable will be lower or higher than the original value. The standard deviation of a set of outcomes describes the variability or dispersion of the outcomes around the expected value (mean). A high standard deviation implies that it is more likely for an actual value of the variable to be further away from the mean, i.e. outcome of project is more uncertain. The minimum and maximum values specify the two extreme sides, up to which an actual outcome of a variable may reach.

The risk analysis software simulates changes in the defined risk parameters and model’s results are recorded as “risk forecasts”. The risk forecasts measuring the financial performance of the project are the ADSCR ratios for years 2004, 2005 and 2006; the DSCR ration for year 2004; the NPV of the real Cashflow Statement from the Owner’s Point of View. The risk forecasts measuring the economic and distributive impacts of the project are: the NPV of the Statement of Economic Resource Flows; the PV of total externalities as well as the PV of labor externalities, and PV of government externalities from the Statement of Economic Externalities. Following this division, Section 8.2.1 examines the risk results for the financial risk forecasts, and Section 8.2.2 evaluates the risk results for the economic and distributive modules.

8.2.1 Financial Module Results

The selection of the financial risk forecasts is not accidental, as they represent a specific evaluation perspective on the feed project. Thus, the owner’s NPV represents the financial performance of the project as perceived by the owner of this enterprise. The debt service ratios are included to analyze the project’s performance from the banker’s point of view. The results of Monte-Carlo risk simulation are displayed in Table X.

Table X. Risk Analysis Results for Financial Module.

	NPV _{OWNER} (Rand ₂₀₀₂)	ADSCR ₂₀₀₄	ADSCR ₂₀₀₅	ADSCR ₂₀₀₆	DSCR ₂₀₀₄
Static Value	0 mln.	0.77	2.29	3.72	2.37
Mean	-10.95 mln.	0.47	1.86	3.22	1.97
Standard Deviation	72.32 mln.	2.43	3.02	3.14	1.77
Minimum	-244.95 mln.	-13.54	-14.04	-13.15	-5.64
Maximum	223.71 mln.	6.29	9.24	10.92	7.38
Cum. Prob. below Zero or 1.5	58.9%	64.44%	39.21%	23.81%	39.76%

Owner's NPV: Remember that the base-case financial model set the value of the owner's NPV to zero in order to let the feed plant to break even. However, the risk simulation indicates that the NPV of the project will, most probably, be lower than zero indicating an unacceptable investment decision for the owner. The expected value (mean) of the NPV is -10.95 million Rand₂₀₀₂, which would result in a loss to the investor. The cumulative probability of the NPV being below zero is 58.9% which, coupled with a high standard deviation of 72.32 million Rand₂₀₀₂, makes the feed project a risky gamble. Because of this high variation in the NPV, there is a wide gap between the minimum and maximum values. In other words, the risk analysis predicts that there is a roughly 60% chance of project failure, and the investor must re-assess the conceptual and financial design of this feed plant.

Debt Service Ratios: The ratios selected here represent the behavior of the annual debt service capacity of the project to honor its loan obligations as well as the cumulative strength of the project cashflows relative to the amount of debt. It appears is that all the debt ratios have expected values lower than their deterministic values computed in the base case. Thus, the static value of the ADSCR in 2004 is 0.77 while its expected value from the risk simulation appears to be only 0.46. If only the annual debt service ratios are considered then it is clear how the project's cashflows improve over time. Thus, the cumulative probability of being below 1.5, which is assumed to be an acceptable threshold, declines from 64.3% in 2004, to 38.8 in 2005, and to 23.8% in 2006.

The cumulative debt service coverage ratio in year 2004 is significantly bigger than the acceptable threshold of 1.5 in both the deterministic (2.37) and risk simulation (1.98) results. Note that its standard deviation (1.79) is substantially lower than any of the individual annual debt service ratios. Despite the fact that there is still a 40% chance of having a value of DSCR₂₀₀₄ lower than 1.5, the overall financial performance of the feed project from the banker's point of view is acceptable, and the banker will be willing to provide funding to this project.

8.2.2 Economic and Distributive Module Results

A different set of indicators is used to measure the project's performance in the economic and distributive modules. The NPV of the Statement of Economic Resource Flows represents the project's net contribution to the national economic welfare. The total amount of economic externalities generated by the project is measured by the PV of the Statement of Economic Externalities. The stakeholder impacts are represented by the present values of the externalities accruing to labor and to the Government. Table XI summarizes the results of the risk simulation.

Table XI. Risk Analysis Results for Economic Module.

	NPV _{ECONOMY} (Rand ₂₀₀₂)	PV _{EXT} Total (Rand ₂₀₀₂)	PV _{EXT} Labor (Rand ₂₀₀₂)	PV _{EXT} Government (Rand ₂₀₀₂)
Static Value	-14.46 mln.	-4.40 mln.	4.65 mln.	-9.04 mln.
Mean	-24.29 mln.	-3.58 mln.	4.62 mln.	-8.20 mln.
Standard Deviation	77.00 mln.	8.25 mln.	0.10 mln.	-8.20 mln.
Minimum	-264.39 mln.	-20.14 mln.	4.23 mln.	-24.56 mln.
Maximum	226.11 mln.	31.92 mln.	4.97 mln.	27.06 mln.
Cum. Prob. below Zero	66.1%	73.9%	0.1%	87.8%

Economic NPV: There is a discrepancy between the static economic NPV of –14.46 million Rand₂₀₀₂ and its expected value of –24.29 million Rand₂₀₀₂, and there is a 66% chance of having a negative economic NPV. The standard deviation of the economic NPV (77.00 million Rand₂₀₀₂) is higher than the standard deviation of the financial NPV from the owner's point of view (72.32 million Rand₂₀₀₂), which signifies a higher risk variation in the economic outcome.

With a wide difference between the recorded minimum (–264.39 million Rand₂₀₀₂) and maximum (226.11 million Rand₂₀₀₂) values of the economic NPV, the final amount of net economic impact is a risky game. The most likely economic consequence of this project would be some amount of net loss of the national welfare.

PV of Total Externalities: The expected value of the PV of total externalities is –3.58 million Rand₂₀₀₂, which is a marginally better result than its deterministic PV amounting to –4.40 million Rand₂₀₀₂. The cumulative probability of this PV being below zero is 73.9%, with the lowest value of the PV being –20.14 and highest 31.92 million Rand₂₀₀₂. There is some variation in the expected value, measured by a standard deviation of 8.25 million Rand₂₀₀₂, which is a substantially smaller standard deviation than the standard deviation of the financial and economic NPVs.

PV of Labor Externalities: The amount of labor-accruing externalities is not expected to change much from the deterministic case, which results in the PV of 4.65 million Rand₂₀₀₂, to the risk simulation expected value of 4.62 million Rand₂₀₀₂. There is a little variation recorded in the expected value (0.10 million Rand₂₀₀₂), and the cumulative probability of the PV of labor externalities is almost zero, i.e. the labor will definitely gain from the project.

PV of Government Externalities: A more complex picture is drawn on the externalities allocated to the Government. The deterministic analysis resulted in an amount of –9.04 million Rand₂₀₀₂ of externalities accruing to the National Government, and the risk simulation returned an expected value of –8.20 Rand₂₀₀₂. The cumulative probability of the PV of Government's externalities being below zero is 87.8%, which means that while the expected PV of the Government's externalities is somewhat lower than in the deterministic case, there will be almost a certain loss for the National Government.

9. CONCLUSIONS

This study has completed an integrated financial, economic, stakeholder, sensitivity and risk analysis of the proposed animal feed plant in Polokwane. The plant is going to enter the existing industry where a number of domestic manufacturers already compete for the consumer. The most likely impact on the industry will be a reduction in the market share held by the existing feed producers. The existing manufacturers will either have to exit the feed industry or to penetrate further around Polokwane and, perhaps, even beyond. The findings of the analysis can be summarized by sections, reflecting the structural organization of the study.

9.1 Financial Analysis

From the banker's perspective, the feed plant would be an acceptable project to finance under the proposed finance scheme. Because the lion's share of the initial investment is financed by the owners, the bank's risk exposure is quite limited. The annual debt service ratios, except the first loan repayment, are well above the 1.5 benchmark and the cumulative debt service ratios are also pretty high. The bank can further reduce its risk by negotiating collateral in the form of the title on the fixed assets of the plant. In short, this is an acceptable project from the banker's point of view.

For the owners of this plant, the evaluation is less conclusive in regard to actual profitability of the enterprise, since the "break-even" approach was taken in order to find out the critical level of the milling fee. But it is clear that with the given market feed prices and project's cost structure; the break-even value of the milling fee is 258.8 Rand₂₀₀₂/ton. If the plant actually achieves or exceeds this margin, the owners will have a profitable business, while a failure to maintain the break-even milling fee would mean a financial loss. A further insight into the owner's point of view is gained in the risk analysis.

9.2 Economic Analysis

The economic evaluation reveals that the project will have a negative impact on the economy. The net present value of economic resource flows is -14.46 million Rand₂₀₀₂, which means that the economic welfare will suffer a loss. This figure includes the financial cashflows

and estimated flows of externalities generated by the project. The largest amount of negative externalities comes from the production of the feed, which causes an additional pressure on the foreign exchange market through usage of tradable inputs. In other words, the negative externalities are mostly caused by the premium on the additional foreign exchange transactions. The project does not pay financially for this premium, and the economic costs are borne by all the other economic agents in South Africa. Thus, the economic impact of the feed plant is negative, and the National Government must consider whether it should support such projects.

9.3 Distributive Analysis

The estimated present value of economic externalities generated by the feed project amounts to -4.00 million Rand₂₀₀₂, which is a considerable negative externality to the South African economy. The allocation of this externality is such that the labor benefits by the estimated amount of 4.65 million Rand₂₀₀₂, and the National Government incurs a loss amounting to 9.04 million Rand₂₀₀₂. The labor externalities are created by wages set at a higher level than the supply price of labor. Most of the negative externality accrues to the National Government and this can be again explained by the foreign exchange premium on the feed ingredients. The Government does collect taxes on the investment and operating items of the project as well as the corporate income tax, but the negative externality from the foreign exchange premium overweighs the tax collections. Thus, the labor stands to enjoy some positive externalities due to the project, but the National Government will suffer a much substantial loss.

9.4 Sensitivity Analysis

The model is very sensitive to the following parameters: change in cost of feed ingredients, change in milling fee, economic opportunity cost of capital, foreign exchange premium, disturbance factor to real exchange rate, domestic inflation rate, tax holiday duration, accounts receivable, accounts payable, composite demand elasticity for meat, and supply elasticity of feed by other manufacturers. Some parameters rather have a moderate impact on the project's results and such a list would include: investment cost overrun factor, method of finance, real interest rate, and loan grace period. The model has a low responsiveness to changes in the following parameters: foreign inflation rate, loan repayment period, labor real wage growth, and electricity real charge growth.

9.5 Risk Analysis

The Monte-Carlo risk analysis, which was performed on the model, suggests that under the risk simulation the project is likely to have even poorer performance than in the deterministic financial and economic model. The expected values of the financial and economic flows are lower than the computed net present values, and there is a 60% chance of project failure for the owner's point of view. Despite the fact that the model breaks even financially, the risk analysis puts this under doubt. The expected value of the economic NPV and PV of total externalities are also negative and it is unlikely to contribute a net benefit to the country's welfare. The risk analysis results confirm that labor is the net beneficiary of the project, while the National Government will have to carry the burden of created negative externalities.

9.6 Overall Assessment

The overall evaluation of this project should warn the project owners about the substantial degree of risk associated with the proposed feed plant, as the project may not be able to recoup the capital invested. There could be ways to improve the project performance through skillful management but the threat still remains, and all concerned parties must be aware of this.

The National Government may reconsider its incentives policy towards foreign investment in order to make the grant rules more flexible and to create a better selection shield against projects harming the competitive domestic producers. The particular issue of whether the grant is the most appropriate form of incentive for foreign investment is very questionable. On the example of this study, such a cash grant does not play a crucial role once the foreign investor is convinced to do business in South Africa. This finding points out that some other business factors really shape the investor's decision to undertake a green-field project in the country, rather than the availability of the grant itself.

It is also doubtful that the Government's true intention is to support foreign investors in the sectors where existing domestic producers are competitive. Such a case does not justify for the direct government intervention and, instead, is likely to create an artificial distortion to the market forces. The economic will lose due to a cut back in the production by the existing domestic producers, while the foreign investor could be the one enjoying the benefits.

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ANNEX A