PROFITABILITY ANALYSIS OF PILOT PLANT UTILIZING WASTE CASSAVA PEELS AND PULP AS SUBSTITUTE FOR MAIZE IN ANIMAL FEED FORMULATION

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ABSTRACT

The Government of the Republic of Ghana has initiated a major revolution in the cassava starch, salt, oil palm and cotton industries. These are industrial raw material bases for many commercial products. Cassava starch is the base material for production of over 2,000 kinds of products, for example, starch syrup, grape sugar, foodstuffs, modified starch, medicaments, cosmetics, shoe polish, dry battery and chemicals for floatation. It is estimated that 2 million tonnes of cassava crop will be produced over the next ten years, yielding about 480,000 tonne of cassava starch and about 640,000 tonne of cassava peels. The cassava starch revenue is projected at about US$96 million annually. Cassava starch and peel constitute approximately 22.5% and 1.4% of the cassava tuber, respectively. The reported composition of fresh cassava peels are moisture (25-30%), fiber (50-60%), starch (4-5%), protein (0.7%) and sugars (2.0%). Maize bran constitutes between 25 and 40% of the feed in pigs, rabbits, poultry and sheep formulations. The cassava pulp constitutes about 8.6% of the cassava tuber and it is a large source of carbohydrate and fiber for animal feed. With the expressed interest in the cassava starch, the technical problem is the utilization of the cassava peel and cassava meal by-products. The utilization of the by-products in animal feed formulation for replacing substantial amounts of maize is the subject of this paper. Further the financial and economic feasibility of a pilot plant production of animal feed was established. The project is financially feasible at capacities greater than 60% of installed plant capacity. The liquidity ratios were; current ratio 2:1, quick ratio 1:1 and debt ratio less than 0.5.

***Keywords**: COVE, cassava starch, peel, feed formulation, pilot plant, tonnne per annum (tpa).*

INTRODUCTION

A wide variety of materials is employed in the manufacture of assorted animal feed. The most general ratiò are maize 36.8%, milo 25.2%, wheat bran 2.6% molasses 1.9%, soybean 11.1%, fish meal 3.3% and others. The major cost of production is the raw materials cost (UNIDO, 1981). The agro-industrial by-products available for animal feed formulations include copra cake, palm kernel meal, cocoa pod husk, cocoa bean shells, cocoa expeller cake, wheat bran, rice bran, maize bran and millet.

In most parts of the developing world, the major concern of animal husbandry today is the extent to which production can be maintained as the human population increases. The ranges of the main ingredients in poultry and piggery feeds are as in Table 1. The carbohydrate component, mainly maize and cassava constitute about 59.5% for poultry feed and 47% for pig feed.

A major constraint to the livestock industry in developing countries is unavailability and/or high cost of feed ingredients, the major component being edible maize. Cassava peels (CAP) and cocoa pod husks (CPH) are available in large tonnage as waste and are suitable for use in livestock feeds. Both CPH and CAP can partly replace some of the maize in the diets of poultry, pigs, sheep and rabbits and can be an admixture to grass for cattle feed.

The chemical composition of the typical ingredients of animal feed is shown in Table 2. The nitrogen-free-extract in maize is comparable

Table 1: Main Ingredient Ranges of Poultry Feed and Piggery Feed Formulation (%)

	Poultry (kg)			Piggery (kg)		
	Day Old	Grower Layer	Broiler Day old to Grower	Weaner	Grower	Finisher
A. Carbohydrate	58	60	60	58	52	27
B. Protein	25	28	25	25	22	5
C. Bran	15	10	14	15	22	65
D. Vitamin and Mineral	1.5	1.5	0.5	1.5	3.5	2.5
E. Salt	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100

***Source**: Animal Science Department, KNUST, Kumasi (2004)*

Table 2: Chemical Analysis of Animal Feed Ingredients (%)

Ingredients	Nitrogen Free Extract	Crude Protein	Crude Fibre	Oil	Calcium	Phosphorus
Maize	45.2	10.2	8.7	2.4	0	0.4
Cassava Peel	75.7	2.0	4.0	1.3	0.3	0.4
Cocoa Pod Husk	44.5	6.5	3.2	1.0	0	0.3
Wheat Bran	52.7	17.1	13.7	44.0	34.0	1.3
Brewer's Spent	59.3	19.2	13.5	3.8	0	0
Copra cake	58.5	19.5	16.5	2.1	0	0
Guinea Grass	37.1	7.6	3.8	1.2	0	0
Osters Shell	0	0.7	0	2.5	0	0
Osters Shell	0	0.7	0	2.5	0	0
Fish Meal	0	70.0	4.0	10.0	4.0	5.8

***Source**: Adomako et. al. (1999)*

with cocoa pod husk but it is much higher in cassava peels.

The crude protein and fiber contents of cassava peel and cocoa pod husk are comparatively low, but could be supplemented with cassava meal.

The Government's Special Initiative on Cassava Starch Production

The Government of Ghana has embarked on an integrated programme for production of cassava starch for export as a special initiative of the President of Ghana. Cassava constitutes about 22% of agricultural gross domestic product GPD, but has the lowest entry barriers to production, compared to other major crops in Ghana. The volume of production of cassava in Ghana is currently about 7 million tonne per annum. The production volume can be increased, but the major constraint is the absence of a guaranteed market. The key to addressing the constraint is to add value by processing the cassava into starch, Report on the President's Special Initiative (PSI) on Cassava Starch Production and Export. The mechanism for achieving the objective is through an innovative farmer-ownership scheme called the Corporative Village Enterprise (COVE) scheme. The COVE model is based on the concept of establishing large scale export oriented enterprise collectively owned by farmers in rural communities and managed by high caliber professionals with proven managerial and technical expertise. It is estimated that a total of 50,000 core farmers, both existing and new, each with a farm holding averaging 1 acre of cassava will be registered under the COVE Project. It is further estimated that 2 million tonne of cassava will be produced over the next ten years. It is projected to produce 480,000 tonne per annum (tpa) of starch and gross revenue of about US$96 million. The analysis indicates that 30,345 tpa of cassava peels, 183,273 tpa of pulp and 804,371 tpa of fruit liquor by-products will be produced.

The Ayensu Starch Company Limited (ASCo)

The ASCo prototype plant was established as the first initiative with a cassava starch capacity of 22,000 tpa and only 5% of the projected national target. Table 3 shows the projected cassava tuber output, cassava starch yield and the by-products that will be generated.

Table 3: Generation of By-products of Cassava Starch Based on Ayensu Starch Company (22,000 tonne/annum) Projection

	Percent Capacity of Target National Starch Production					
Production Capacity	ASCo	1	2	3	4	5
Maximum Projection	5%	10%	20%	25%	50%	100%
Cassava Tuber (tpa)	97,680	213,120	426,240	532,800	1,065,600	2,131,200
Starch Product (tpa)	22,000	48000	96000	120000	240000	480,000
Peels By-product (tpa)	1,400	3,055	6,109	7,636	15,273	30,545
Pulp By-product (tpa)	8,400	18,327	36,655	45,818	91,636	183,273
Fruit Water (tpa)	36,867	80,437	160,874	201,093	402,185	804,371

The cassava variety being currently cultivated for Ayensu Starch is *AFISIAFI* also known as *MADUMAKU* reputed for its high yield and disease resistance. The cassava starch and peel constitutes approximately 22.5% and 1.4% of the cassava tuber, respectively. The compositions of cassava peels are 25-30% moisture, 50-60% fiber, 45% starch, 0.7% protein and 2.0% sugars. The cassava meal and peels can replace some maize constituent in animal feed. The cassava pulp constituting about 8.6% of the cassava tuber is a large source of carbohydrate and fiber for animal feed.

The estimated cassava peels and pulp by-products from the production of 22,000 tpa of cassava starch based on ASCo plant are 1,400 tpa and 8,400 tpa, respectively. The by-products constitute about 44.5% of the starch produced. The cassava peel, pulp and cocoa pod husks, in cocoa plantation areas, are relatively cheap raw material base for the proposed commercial animal feed pilot plants. These raw materials can replace some maize/corn component in animal feed formulation.

Researches in Unconventional Animal Feed Formulation

The Cocoa Research Institute, Tafo, initiated limited feeding trials on cattle in 1964. In 1978, the livestock feeding trials were expanded to include experts from Animal Research Institute (CSIR), Accra, Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi and the Department of Animal Science, University of Ghana, Legon The composition of ingredients for pigs, rabbits, poultry and sheep recommended by the scientists is shown in Table 4.

The feed trial results indicated that maize can be replaced with CPH up to 25% in the diet of pigs, 10% in the diet of broilers and 25% in the diet of rabbits without any deleterious effect on the performance and carcass characteristics of the animals. The cocoa pod husk, however replaced mainly dried guinea grass in the ration for sheep. The performance on 60% CPH ration was the same as that on a 66% grass control diet. However, substituting grass with CPH up to 45% gave twice as much body weight gain and feed conversion efficiency as the control containing 66% guinea grass (Adomako et. al., 1999). The CPH component can be replaced with the cassava starch meal by-product from the ASCo Starch Plant.

THE METHODOLOGY

The number of research papers on animal feed particularly those with cocoa pod husk and cassava peels as components was reviewed. Preliminary researches in optimum drying curves of cassava peels and dewatering of cassava meal were undertaken at the laboratory. Both dry cassava peels and dry meal were milled. Batch animal feed formulation containing varying amounts of cassava peels and meal, as substitute for maize, were prepared and compared with control formulation for poultry, pigs and sheep.

Comparative cost of each feed formulation with commercial maize as index was computed. Feasibility analysis, based on cassava peel and cassava meal from the ASCo Plant and replacement of at least 25% of the maize component of regular animal feed formulation, was studied. Table

Table 4: Percentage Composition of Ingredients in Livestock Feeds

Ingredients (%)	Pigs	Rabbits	Poultry	Sheep
Guinea Grass	0	0	0	7.5
Corn Bran	36	25	46.6	25
Brewer's Spent Grain	24	30	0.4	7
Cocoa Pod Husk	25	42	10	60
Fish Meal	4	2	24.7	0
Oysyer Shell	0.5	0.5	1.1	0
Common Salt	0.5	0.5	0.2	0.5
Copra	10	0	17	0
Total	100	100	100	100

Source: *Adomako et. al., (1996).*

Table 5: Nutritional Analysis of Control Feed and Optimum Replacement of Maize in Poultry, Piggery and Sheep Diets

A. Poultry	NFE (%)	CP (%)	CF (%)	Calcium (%)	Phosphorus (%)
Control (56% Maize)	25.62	8.05	36.68	0.94	1.55
Optimum (26% Maize)	21.61	6.22	47.5	1.26	1.59
B. Piggery					
Control (51.5% Maize)	16.58	10.31	47.16	0.39	0.54
Optimum (11.55 Maize)	15.61	8.11	57.81	0.85	0.54
C. Sheep					
Control (14% maize)	10.9	28.73	40.09	0.3	2.93
Optimum (60% Maize)	8.79	9.7	66.31	0.53	0.66

Table 6: Cost Effects of Replacement of Portions of Maize in Animal Feed

	Commercial Feed (¢/kg)	Optimum Formulation (¢/kg)	Gross % Cost Effectiveness
Poultry Feed	3,520.0	1,573.0	0.55
Piggery	2,105.0	1,035.9	0.51
Sheep	2,105.0	965.0	0.54

4 shows the optimum feed formulation used in the analysis.

RESULTS AND DISCUSSION

Results 1: Optimum Feed Formulations for Poultry, Piggery and Sheep

The results of the optimum feed formulation compared with commercial feed for poultry, pigs and sheep based on analysis of nitrogen free extract (NFE), protein (CP), crude fiber (CF), calcium and phosphorus are shown in Table 5. The objective was to achieve about 90-95% of nitrogen and 80-85% of protein on comparative basis.

The results showed that the carbohydrate content of poultry and piggery feed can be replaced by cassava peel and cassava pulp (meal) by as much as 30% and 40%, respectively. Ruminant feed may contain 60% peel and cassava meal. The unit cost of optimum feed formulation for poultry, pigs and sheep was projected at ¢1,573, ¢1,036 and ¢965, respectively as compared with commercial feed unit cost of ¢3,520, ¢2,105 and ¢2,105 feed. The cost effectiveness of maize replacement is analyzed in Table 6.

The analysis showed about 54% cost effectiveness in the cassava peel and cassava pulp based animal feed formulation.

Results II: Investment Cost

Investment Cost

The investment cost for siting a pilot plant within 10 km of say the ASCo Starch Producing Plant was analyzed for between 160,000-996,000 tpa feed formulation plant, i.e., a plant utilizing between 10-60% of cassava peel and

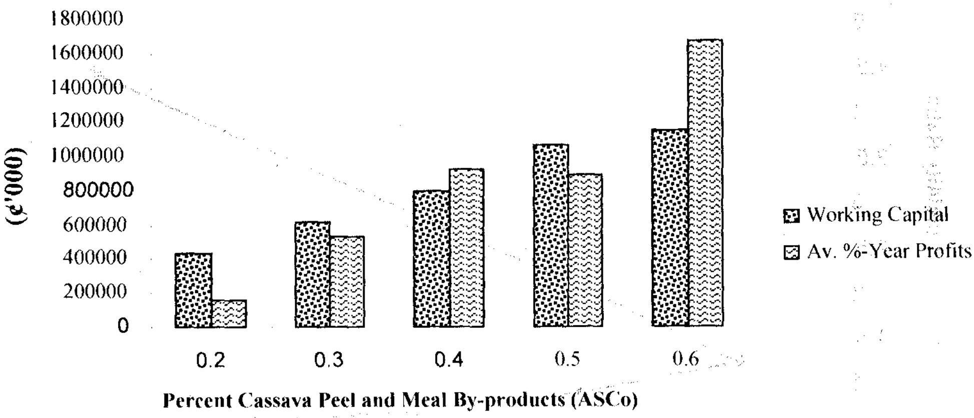

Fig. 1: Profitability as function of working capital

cassava pulp by-products from the ASCo prototype plant. The investment cost is projected at about ¢2.8 billion (US$305,392).

Initial Working Capital Requirement

The profitability is a function of the working capital requirement. The average profits and initial working capital requirement are shown in Fig. 1.

The working capital required for 60% of plant capacity is about ¢1.15 billion. The year end profit was projected at about ¢1.65 billion.

Break-even Production

The investment analysis indicated lower profits for processing between 10-30% cassava peel and meal generated from the ASCo Plant. The profits increased from a minimum of 40% to a maximum of 60% utilization of the by-products. The

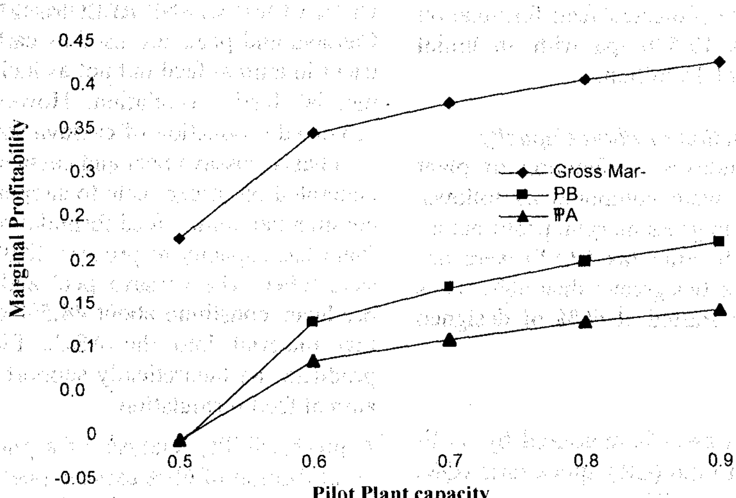

Fig. 2: Profitability as function of Plant Capacity

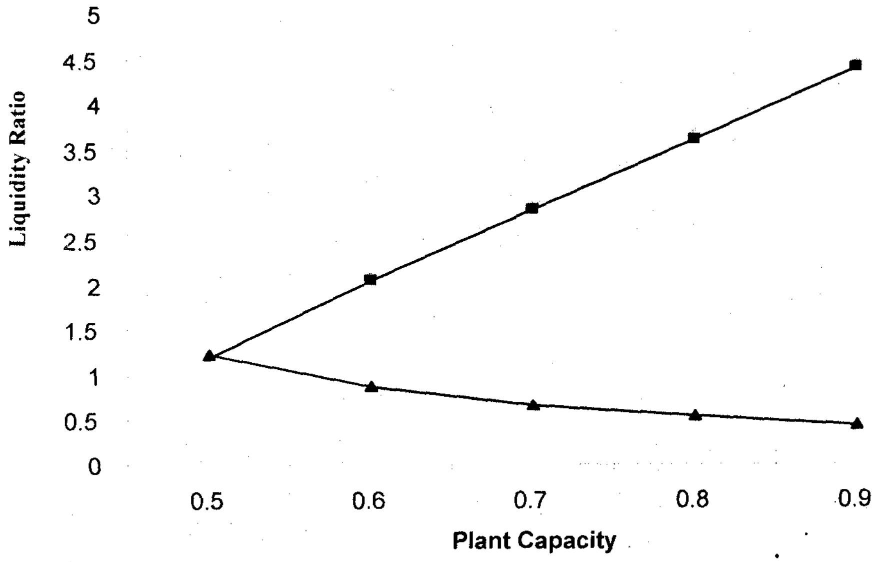

Fig. 3: Liquidity as function of Plant Capacity

working capital can be recouped at 40% capacity utilization. The financial analysis was, however based on initial plant capacity of 60% of ASCo plant capacity generating about 4,880 tpa of cassava peel and meal by-products. This may be increased as more by-product raw materials become available. The projected feed formulation plant capacity was 19,536 tpa with an initial working capital of ¢1.15 billion.

Profitabilty as Function of Plant Capacity

The profitability indexes as function of plant capacities (Fig. 2) were computed as follows. Marginal increases in gross margin, profit before tax (PBT) and profit after tax (PAT) were observed at plant capacities greater than 60%. Thus production may be started at 60% of designed plant capacity.

Liquidity Analysis

The solvency of an asset is measured by its liquidity, i.e., current ratio (CR), quick ratio (QR) and debt servicing ratio. These ratios were computed and are presented graphically in Fig. 3. At minimum 60% plant capacity the project is deemed liquid at CR ratio 2:1, QR ratio 1:1 and above and debt ratio less than 0.5. These are within financially acceptable ranges for the manufacturing industries.

CONCLUSIONS AND RECOMMENDATIONS

Cassava and peels are used as carbohydrate nutrient in animal feed but not as inclusion in commercial feed formulation. However, with the projected production of cassava starch on industrial basis, cassava peel and cassava fiber will be generated on larger scale to support inclusion in commercial animal feed formulation. The ASCo Plant has capacity to process 22,000 tpa of cassava tuber. The cassava peel and pulp, as by-products, constitute about 44.5% of the cassava raw material into the ASCo Plant. The by-products can theoretically support 39,000 tpa of animal feed formulation.

A pre-feasibility analysis of a pilot plant based on utilization of 60% cassava peel and meal and replacement of 30% of maize content in feed indicated favourable return on investment and liquidity of the proposed animal feed formulation plant. Preliminary discussion at the Private Sector Ministry indicated the availability of investment funds for such a project.

The target beneficiaries of the project are 1) District Assemblies and farmers' cooperatives in cocoa producing areas and in the vicinity of the proposed cassava starch plants, 2) Joint venture between private entrepreneurs and starch producing companies which will supply cassava peels and cassava meal by-products to the proposed animal feed plant and 3) Purely private enterprise purchasing cassava peels and cassava meal from the cassava starch plants.

The economic benefits for large scale industrial production of animal feed and availability will include: 1) The encouragement of large scale cattle farming in the country, 2) Cattle ranch development and greater care of cattle in the ranches, 3) Large scale piggery, sheep and goats farming, 4) Control of the nutrition of animals and curtailment of the movements of cattle to southern Ghana in the dry seasons of northern Ghana.

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