

# FARM BUDGETING TECHNIQUES FOR COCONUT BASED FARMING SYSTEMS

by

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## Abstract

Partial budget analysis is a simple farm budgeting technique which is often used in conjunction with the assessment of the economic viability of a component technology or cropping pattern in farming systems research. As the term suggests, partial budget considers only the variable costs involved in changing from one farming technology to another, usually improved technology. Under partial budget, the economic viability of a recommended technology maybe assessed through the calculated net benefits or returns above variable costs (RAVC) but the more significant analysis is in terms of the marginal rate of return (MRR). Marginal analysis shows what farmers can expect to gain, on the average, in return for what has been invested in changing from one farm practice to another. The analysis also considers the variability of input and product prices and the minimum acceptable rate of return when farmers are willing to adopt a given technology. Partial budget analysis could be used as one of the techniques in the selection of the best alternative or profit maximizing coconut + other crop combination or coconut-livestock integration.

## 1. Introduction

Farm management involves a decision making process on how available and often limited resources can be utilized efficiently to attain maximum benefits. With the land frontier about to be reached, there is an increasing need for maximizing land use through multi-

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enterprise farming (multi-cropping and crop-livestock integration) which offers opportunities for improved productivity and increased income. This need became more pronounced with the advent of farming system research or FSR (Calub, et al, 1988) which the Department of Agriculture (DA) currently promotes. In farming systems, the priorities, strategies and resource allocation decisions of farmers are considered, most often in conjunction with on-farm research which identify and adapt location-specific technologies (Rosario, 1990). Researchers conduct experiments on farmers fields to formulate improved technologies under farmers' conditions. Results of these experiments usually form the bases of recommendations to farmers. To make good recommendations researchers must be able to evaluate alternative technologies in terms of their economic viability, technical feasibility, as well as their acceptability to farmers. The economic viability of these technologies maybe assessed through budget analysis.

### **1.1 Objectives and Scope.**

The main objective of this paper is to present farm budgeting techniques in the selection of profit maximizing multicrop or crop-livestock combination in adopting coconut based farming systems. It focuses on the simple procedures which relate to the costs and returns type of analysis in contrast to more sophisticated quantitative models such as linear programming and multi-period budgeting.

The procedures discussed in this paper were mostly adopted from CIMMYT's (1988) economics training manual for analyzing the results of on-farm agronomic experiments for farmer recommendation. The manual for analyzing crop-livestock integration by Calub, et al (1988) was also useful.

Results of on-farm research from the Philippine Coconut Authority (PCA), Bureau of Agricultural Research (BAR) and information from the Philippine Council for Agriculture, Forestry and Natural Resources

Research and Development (PCARRD), were part of the data utilized to illustrate the application of farm budgeting techniques.

## **2. Philippine Coconut Industry and Prospects for Multi-Enterprises**

### **2.1 Importance of Coconut in the Economy.**

Coconut ranks third to palay and corn in terms of contribution to gross value added (GVA) in agriculture. In 1989 coconut shared 1.5 percent to GVA in agriculture next to palay (6.2 percent) and corn (1.7 percent) (NSCB, BAS, 1990). Export earnings from coconut by-products in 1988 is about 32 percent of total value of agricultural exports (BAS, 1989) or 8.1 percent of total value of Philippine exports (UCAP, 1989). It provides livelihood to 1.5 million farmers in 1984 (PCA, 1988).

### **2.2 Status of Coconut Farming.**

The agricultural census in 1980 listed a total of 1.6 million coconut farms, majority or 78 percent were farms of less than five hectares. Trinidad (1989) also reported that 91 percent of the total number of coconut farmers cultivate coconut areas of less than five hectares, the average holding of which is 3.2 hectares. Of an estimated 3.2 million hectares cultivated to coconut (BAS, 1988) the PCA surveys (1974-1980) indicated that one third of this area were intercropped. A land use map developed by Jarmin of the Bureau of Soils showed coconut multi-cropped area at 0.9 million hectares.

Coconut productivity levels is placed at an average of 36 nuts/tree/year at the national level which will provide an annual income of P2,000 per hectare of monocropped area at current prices (PCA, 1984). But income may fluctuate depending upon copra world prices. Several cross-sectional income studies of coconut farms in different locations produced varied results with net incomes ranging from P165 per hectare

to P2,494 per hectare (Valiente, Jr. et al, 1979; Olalo, 1975; UCAP, 1981; Margate and Magat, 1983).

## **2.3 Status and Prospects for Coconut Farming Systems**

### **2.3.1 Multicropping.**

An estimated two million hectares of coconut land area are suitable for intercropping (Gapasin, 1983). Several cropping patterns (annuals, perennials and fruit trees) under coconut have been recommended under specific locations by the coconut Multi-cropping project (Table 1). The projected income under coconut monoculture was P821 per hectare, with additional incomes from several cropping patterns which ranged from P281 to P14,755 per hectare over a 10 year period (Pablo, 1983). Aside from increased income, intercropping places the farmer at lesser risk to epidemic of diseases and outbreak of pests (Pablo, 1983). Studies on intercropping shade tolerant crops by Prudente, et al (1979) and by Margate and Magat (1983) resulted in increased nut yields (Table 2) due to the spillover effects of cultivation, weeding and fertilization of the intercrops.

### **2.3.2 Crop-Livestock Integration.**

The Philippine Council for Agriculture, Forestry and Natural Resources, Research and Development (PCARRD, 1982) estimated that about 22 percent of the total coconut area in the country serve as tethering or grazing ground for cattle, carabaos and goats. It has been observed however, that few farmers adopt improved farming systems. At present, this is being addressed through the coconut-livestock farming systems approach which integrates management of coconut, pasture and livestock. There are advantages and disadvantages of coconut-livestock farming combination but the former outweigh the latter. Like crops, integrating livestock farming under coconut provides additional income which may range from P1,500 to P2,000 of one F1 dairy cow per lactation period of 220 days based on farmers' experience in Sariaya, Quezon (PCARRD, 1982) or an increase from 56 to 60 percent of the income from

**Table 1. Recommended Cropping Patterns under the Coconut Multiple Cropping Project**

	:	Intercrops
1. Coconut	:	papaya + pineapple + vegetable
2. Coconut	:	banana + coffee
3. Coconut	:	banana + cocoa
4. Coconut	:	banana + coffee/cocoa + balckpepper
5. Coconut	:	fruit trees + blackpepper
6. Coconut	:	cocoa/coffee + rootcrops (gabi or ube)
7. Coconut	:	banana + lanzones + coffee/cocoa
8. Coconut	:	pineapple + legumes + ginger + pineapple
9. Coconut	:	green corn
10. Coconut	:	vegetables/legumes

Source: Pablo, 1983.

**Table 2. Average Nut and Copra Production under Different Cropping Patterns, Per Tree and Per Nut, 1975-1982**

Cropping Pattern	Nuts Per Palm (no.)	Copra Per Palm (kgs.)	Copra Per Nut (grams)
1. Coconut monoculture (control)	64.1	18.5	43.9
2. Coconut + balck- pepper	65.0	19.4	47.8
3. Coconut + banana + papaya/cocoa	72.1	21.7	48.9

\*/ Papaya was replaced with cacao, 1977-1982  
Source of basic data: Margate and Magat (1983).

coconut from a Masbate ranch (Calub, undated). The other advantages are lesser weed overgrowth due to grazing, nutrient recycling through animal manure which contribute to soil fertility, shade for animals, and additional meat and milk for the country. Some of the noted limitations are soil compaction, depletion of soil nutrients due to competing forage, soil moisture competition, and in the case of cattle dung, a breeding place for rhinoceros beetle in the absence of good dung management.

### **3. Farm Budgeting Techniques**

#### **3.1 What is Farm Budgeting?**

In the context of farming systems approach, farm budgeting is the assessment of the economic viability of proposed technology(ies) which maybe a component technology, a cropping pattern, or a crop-livestock combination enterprise. The analysis is based on costs and returns data of the proposed technology and those of the existing technology or current farmers' practice (see CIMMYT, 1988 and Calub, et al, 1988).

Farm budgeting shows a farmer the probable returns to his investment and guides him in the selection of alternative technology that will provide the maximum returns out of his available resources. The analysis is usually presented on a per unit of land basis (e.g. per hectare).

#### **3.2 Types of Farm Budgeting.**

There are two types of farm budgeting or budget analysis - partial and complete.

##### **3.2.1 Partial Budgeting.**

It considers only the difference in variable costs between two alternative technologies, that is, the recommended or new technology vs. existing technology or farmers' practice. It includes costs of labor and material inputs such as fertilizer and chemicals which

usually comprise variable costs, in association with the change or variation in farm operations. As partial budget do not incorporate the other production costs (fixed costs), the difference between the variable costs and the total value of production represents only net benefits which is not the same thing as profit (CIMMYT, 1988).

Partial budget includes information on the average yield per hectare of the existing technology (farmers' practice) and yield of the new technology, the gross field benefits, total variable costs of the technologies being compared.

Partial budgeting is commonly used in the economic assessment of a component technology. Examples of component technology are the current farmers' practice of handweeding and an alternative of applying herbicide (Table 3), the raising of bobbsrain broilers for nine weeks instead of six weeks (Table 4).

The procedures in evaluating the economic viability of a component technology can also be applied in **enterprise budgeting**, which is the economic assessment of experimental cropping patterns and crop-livestock combination (Calub, et al, 1988). Enterprise budgeting is shown in the assesment of coconut intercropping trials from BAR (Table 5), from PCA (Table 7) and estimated income and expenses of coconut-cattle farming combination by PCARRD (Tables 6 & 6a).

In partial budgeting the economic viability of alternative technologies maybe assessed through the change in net benefits (also known as returns above variable costs (RAVC), or more significantly through the marginal rate of return (MRR).

**a. Change in net benefits (change in returns above variable costs or RAVC).** Net benefits or RAVC is simply the difference between gross benefit or value of production and total variable costs. It is also termed as **net returns** (Calub, et al, 1988).

**Table 3. Partial Budget, Handweeding vs. Herbicide Application**

Item	T R E A T M E N T S	
	Handweeding pesos (P)	Herbicide application pesos (P)
Variable costs		
Cost of herbicide (P250/liter x 2 liters/ha)	0	500
Labor cost, herbicide application (P50/day x 2 days/ha)	0	100
Labor cost, handweeding (P50/day x 8 days/ha)	400	0
Total variable costs	400	600
Benefits (returns)		
Average yield (kg/ha)	2000 1/	2400 1/
Adjusted yield (kg/ha)	1800 2/	2160 2/
Gross benefits	3600	4320
Net benefits (RAVC)	3200	3720

1/ Results of experiments from representative farmers' fields.

2/ Estimated yield from farmers' practice of the two treatments were assumed 10 percent lower than experimental results.

Source: Adapted from CIMMYT, 1988.

$$\begin{aligned}
 \text{MRR} &= \text{P}3720 - 3200 \\
 &= \text{P}600 - 400 \\
 &= \text{P}200 \\
 &= 2.6 \text{ or } 260\%
 \end{aligned}$$

**Table 4. Partial Budget, Nine-week old vs. Six-week old Cobb Strain Broilers, December, 1985 - February, 1986**

Item	6 - weeks pesos (P)	9 - weeks pesos (P)
Variable costs		
Feeds (P 0.83/kg)	x 1746 kgs. = 1449.18	x 2619 kgs. = 2173.77
Labor (P 3.60/wk)	x 6 wks. = 21.60	x 9 wks. = 32.40
Water (P 1.00/wk)	x 6 wks. = 6.00	x 9 wks. = 9.00
Total variable costs	1476.78	2215.17
Benefits (returns)		
Weight gain (P 3.25/kg)	x 471.46 kgs. = 1532.24	x 707.19 kgs. = 2298.37
Feedbags (P 1.15/bag)	x 42 bags. = 48.30	x 63 bags = 72.45
Manure (P 0.05/kg)	x 144 kgs. = 7.20	x 216 kgs. = 10.80
Gross benefits	1587.74	2381.62
Net benefits (RAVC)	110.96	166.45

Source: Adapted from Calub, et al, 1988.

$$\begin{aligned}
 \text{MRR} &= \text{P } 166.45 - 110.96 \\
 &= \text{P } 2215.17 - 1476.78 \\
 &= \text{P } 55.49 \\
 &= 738.39 \\
 &= 0.075 \text{ or } 7.50\%
 \end{aligned}$$

**Table 5. Enterprise Budget, Cropping Patterns under Coconut, PTVT site in Daraga, Albay, Cropyear 1986-87**

Cropping Pattern		Variable costs (P/ha)		Yield (mt/ha)		Gross benefits (P/ha)		Net benefits (P/ha)	
Field trial 1									
EP	FP	EP	FP	EP	FP	EP	FP	EP	FP
Coconut	Coconut	1,936	1,518	1.67	1.24	5,177	3,844		
+ gabi	+ cassava	3,901	2,965	4.83	20,685	10,485			
Total			5,837	4,483			25,862	14,329	20,025
Change in net benefits								10,359	
MRR								7.65 or 765 %	
Field trial 2									
EP	FP	EP	FP	EP	FP	EP	FP	EP	FP
Coconut	Coconut	2,026	1,582	2.08	1.66	6,488	5,146		
+ bush sitao	+ cassava	5,746	2,965	2.64	7.11	5,680	10,485		
Total		7,772	4,547			12,128	15,631	4,356	11,084
Change in net benefits								-6,728	
MRR								-2.09 or -209 %	
Field trial 3									
EP	FP	EP	FP	EP	FP	EP	FP	EP	FP
Coconut	Coconut	2,026	1,582	2.50	1.66	7,750	5,146		
+ cassava	+ cassava	3,788	2,965	8.08	7.11	12,425	10,485		
+ corn	+ corn	3,387	2,900	5.45	4.60	18,530	15,640		
+ mung		2,922		0.63		6,302			
Total		12,123	7,447			45,005	31,271	32,882	23,884
Change in net benefits								8,998	
MRR								1.92 or 192%	

EP - Experimental pattern

FP - Farmers' pattern

Source: BAR, 1987

**Table 6. Estimate Costs and Returns of Coconut Plantations,  
Monoculture and with Cattle under Traditional  
and Improved Management, 4 Ha./Farm 1/**

Item	Coconut Mono-culture (Trad. Mgt.) -----	Cattle- Coconut (Trad. Mgt.) P e s o s (P)	Cattle- Coconut (Imp. Mgt.) -----
Income			
Cash Income	4,870	10,400	35,170
Copra sales	4,200	5,440	13,800
Cattle sales		4,120	19,440
Other cash receipts	670	840	1,930
Non-cash income			
Increase in inventory		720	2,310
Total Income	4,870	11,120	37,480
Expenses			
A. Variable Expenses	2,085	3,155	14,510
Cash expenses	1,985	3,155	14,510
Harvesting & hauling	560	700	1,540
Copra making	225	290	740
Weeding	1,200	600	300
fertilization (coconuts)			2,780
Care and upkeep of cattle			
Labor		1,365	2,675
Feed supplements			1,500
Veterinary supplies			500
Pasture fertilization			2,795
Repair and maintenance			850
Miscellaneous costs	100	205	830
B. Fixed Expenses	315	2,860	10,580
Cash expenses		1,100	2,850
Purchase of cattle		1,000	2,250
Insemination costs		100	600
Non-cash expenses	315	1,760	7,730
Depreciation			850
Interest in cap. inv.		1,120	4,275
Interest in op. cap.	315	640	2,605
Total Expenses	2,400	6,020	25,090
Net Returns	2,470	5,100	14,390

1/ Average of the first 10 years of operation.

Source : PCARRD, 1982.

**Table 6a. Enterprise Budget, Coconut Monoculture and with Cattle under Traditional and Improved Management, 4 Ha./Farm**

Item	Coconut Mono-culture (Trad. Mgt.) -----	Cattle- Coconut (Trad. Mgt.) P e s o s (P)	Cattle- Coconut (Imp. Mgt.) -----
Gross Returns	4,870	11,120	37,480
Variable Costs	2,085	3,155	14,510
Net benefits (RAVC)	2,785	7,965	22,970
MRR (1) : (2)	7,965 - 2,785	=	5,180
	3,155 - 2,085	=	1,070
		=	4.84 or 484%
(2) : (3)	22,970 - 7,965	=	15,005
	14,510 - 3,155	=	11,355
		=	1.32 or 132%

RAVC = Total or gross returns - Total variable costs

$$\Delta \text{RAVC} = \text{RAVC2} - \text{RAVC1}$$

Where,

RAVC1 - net benefits of existing technology, and

RAVC2 - net benefits of improved or recommended technology

b. Marginal rate of return (MRR). Marginal benefit is the change in net benefits (change in RAVC) of two alternative technologies (e.g. experimental or recommended technology and farmers practice) divided by their change in marginal costs (variable costs). The results indicate what farmers expect to gain on the average when they decide to shift from one practice (or a set of practices) to another.

$$\text{MRR} = \frac{\text{Marginal net benefits (RAVC2-RAVC1)}}{\text{Marginal costs (TVC2-TVC1)}}$$

Where,

TVC1 - total variable costs of the existing technology, and

TVC2 - total variable costs of the improved or recommended technology

### 3.2.2 Complete Budgeting.

It includes all costs of production (variable and fixed costs) in the calculation of net benefits or net returns and marginal rate of return.

Net benefits = Total or gross returns - total costs

$$\text{MRR} = \frac{\text{Marginal net benefits (NB2-NB1)}}{\text{Marginal total costs (TC2-TC1)}}$$

Where,

- NB1 - net benefits of improved or recommended technology,
- NB2 - net benefits of existing technology,
- TC1 - total costs (variable + fixed costs) of the improved or recommended technology, and
- TC2 - total costs of the existing technology

While the net benefits vary between partial and complete budgeting, the calculation of MRR may not be affected as fixed costs remain constant as shown in the example of handweeding vs. herbicide treatments (Table 8). With total fixed costs of P300 per hectare in both treatments, the computed MRR were the same in partial and complete budgeting.

### 3.3 Net Benefits and Marginal Rate of Return

In the examples of partial and enterprise budgets (Tables 3 to 7), the net benefits of most of the recommended technologies, except in farm trial no.2 of coconut intercropping (Table 5) and the cattle-coconut improved management (Table 6a), were higher in terms of their absolute values. A positive change in net benefits between alternative technologies (from the current practice to the recommended technology) may seem attractive. Further analysis would, however, be needed between the additional benefits derived and the additional costs incurred. This type of analysis is provided by the marginal rate of return.

In the handweeding versus herbicide practices, if a farmer adopt herbicide application he will have to spend additional P200 per hectare in order to obtain additional net benefits of P520/ha. The calculated MRR was 2.6 or 260 percent which indicated that a farmer recovered his P1 plus extra P2.6/ha in net benefits.

In the broiler experiment (Table 4) adopting Cobbstrain broiler for 9 weeks instead of 6 weeks

Table 7. Enterprise Budgeting, Different Coconut Cropping Patterns, Per Hectare, 1975-1982

	A	B	C-1	C-2	C-3	D
	Coconut Alone (Control) (1975-1982)	Coconut + Blackpepper (1975-1982)	Coconut + Blackpepper + Papaya (1975-1977)	Coconut + Blackpepper + Pineapple + Papaya (1975-1977)	Coconut + Blackpepper + Cocoa (1977-1982)	Coconut + Blackpepper + Pineapple + Cocoa (1977-1982)
	P E S O S (P)					
Gross returns						
Coconut	5,450.38	5,752.86	3,029.86	3,590.27	8,143.98	8,340.43
Blackpepper	-	210.80	0	0	239.40	229.40
Papaya	-	-	1,649.60	2,584.40	-	0
Cocoa	-	-	-	-	310.73	365.27
Pineapple	-	-	-	781.80	-	2,495.03
Total gross returns	5,450.38	5,963.66	4,679.46	6,956.47	8,694.11	11,430.13
Variable Costs						
Maintenance, Seeds, Fertilizers & Chemicals	918.93	11,047.34	1,562.01	2,391.26	2,476.22	4,168.94
Harvesting	109.27	110.81	61.57	70.49	152.55	159.60
Hauling	77.74	78.83	39.18	44.86	111.87	117.04
Copra Making	493.35	520.73	292.74	346.89	740.36	758.22
Total variable costs	1,599.29	1,757.71	1,955.50	2,853.50	3,481.00	5,203.80
Net benefit (RAVC)	3,851.09	4,205.95	2,723.96	4,102.97	5,213.11	6,226.33

Source : Margate and Magat, 1983 in Ditablan and Astete, 1985.

	A : B	B : C1	C1 : C2	C2 : C3	C3 : D
MRR	2.24	-7.49	1.54	1.77	0.59

yielded additional benefits of only P55.49 from additional costs of P738.39. The MRR is low, 0.075 or 7.5 percent which is interpreted as additional returns of about P0.08 for every peso additional investment, which showed that the new practice is not economically viable.

In the different cropping patterns for coconut, the experimental pattern (EP) of coconut + gabi vs. farmer's practice (FP) of coconut + cassava yielded MRR of 765 percent which meant additional benefits of P7.65 for every additional peso of variable costs; for coconut + cassava + corn + mungbean (FP) vs. coconut + cassava + corn (EP) the former also proved to be economically viable resulting in MRR of 192 percent or additional P1.92 for every peso additional investment. On the other hand, the experimental pattern of coconut + bush sitao compared to farmer's practice of coconut + cassava indicated a negative change in net benefits of P6,728/ha, MRR of negative 209 percent which showed a loss of P2.09 for every peso additional investment. It is observed, nevertheless, that the yields of coconut under the three experimental cropping patterns are higher than those of the farmer's practice (Table 5).

In the coconut monoculture, coconut-cattle (traditional management), coconut-cattle (improved management alternatives, all technologies resulted in positive benefits with the coconut-cattle improved management practice having the higher net benefits. However, results of the marginal rate of returns indicated that coconut-cattle traditional management provided the highest additional returns of P4.84 for every additional peso investment (Table 6a). The results obtained, however, were with reference to the first 10 years of operation.

### **3.4 Marginal Analysis as a Tool in Farmer Recommendation**

In making recommendations to farmers, researchers are often faced with the question on what is the best alternative technology that would give the maximum net benefits to farmers and what would be the minimum

acceptable rate of return. CIMMYT, 1988 have developed procedures for marginal analysis which could serve as guide in researchers' recommendations as well as in farmers' decision.

#### **4.1. Dominance Analysis.**

First, alternative technologies (as in treatments in a component technology, different cropping patterns) are listed in the order of increasing variable costs from the highest to the lowest. Any technology that has net benefits that are less than or equal to those of a technology with lower variable cost is dominated.

Consider the different cropping patterns under coconut in Table 7. Of the six alternative cropping patterns, total variable costs are increasing, from a low of P1,599.29 per hectare for coconut monoculture to a high of P5,203.8 per hectare for coconut + blackpepper + pineapple + cocoa cropping pattern. Net benefits are also increasing except in cropping pattern no. 3 (coconut + blackpepper + papaya) where it requires higher variable cost than cropping pattern no.1 and no.2 but gives lower benefits. Such is a dominated (D) cropping pattern (Table 9). The dominance analysis has eliminated one cropping pattern due to its low net benefits.

#### **4.2. Marginal Rate of Return.**

The second step is to calculate the marginal rates of return (MRR) of non-dominated technologies. The MRR shows what farmers can expect to gain, on the average, in return for what has been invested in changing from one practice or technology (or set of practices) to another. In the coconut cropping pattern example, intercropping blackpepper under coconut implies a 224 percent rate of return or additional P2.24 for every peso additional investment; blackpepper + pineapple + cocoa, 9.4 percent or P0.09 additional centavos in net benefits for every additional investment; blackpepper

**Table 8. Partial and Complete Budget, Handweeding vs. Herbicide Application**

Item	Partial budget		Complete budget	
	Handweeding	Herbicide	Handweeding	Herbicide
Total variable costs (P/ha)	-	-	300	300
Total fixed costs (P/ha)	400	600	400	600
Gross benefits (P/ha)	3,600	4,320	3600	4,320
Net benefits (P/ha)	3,200	3,720	2,900	3,420

Source : Adapted from CIMMYT, 1988.

$$\begin{aligned}
 \text{MRR} &= \frac{3720 - 3200}{600 - 400} = \frac{3,420 - 2900}{900 - 700} \\
 &= \frac{520}{520} \\
 &= \frac{220}{220} \\
 &= 2.6 \text{ or } 260\% = 2.6 \text{ or } 260\%
 \end{aligned}$$

**Table 9. Dominance Analysis, Different Cropping Patterns Under Coconut**

Cropping Pattern	Total Variable Costs (P/ha)	Benefits Benefits (P/ha)
1. Coconut alone (control)	1,599.29	3,851.09
2. Coconut + blackpepper	1,757.71	4,205.95
3. Coconut + blackpepper + papaya	1,955.50	2,723.96 D*
4. Coconut + blackpepper + pineapple + papaya	2,853.50	4,102.97
5. Coconut + blackpepper + cocoa	3,481.00	5,213.71
6. Coconut + blackpepper + pineapple + cocoa	5,203.80	6,226.33

\* Dominated. Its net benefits are lower than the cropping pattern with lower variable costs.

+ cocoa, 177 percent; and blackpepper + pineapple + cocoa, 58.8 percent (Table 10).

#### 4.3. The Minimum Acceptable Rate of Return.

A positive net benefit or high MRR are not enough bases for recommending new technologies to farmers. A minimum acceptable rate of return to farmers must be considered. Related to this is the alternative or opportunity cost of capital which is the earnings forgone by not putting money to the best alternative use.

New and improved technologies often require additional investment and a farmer may either borrow or use his own earnings. In the case of borrowed capital, an interest rate is charged on it, while if a farmer uses his own money he must consider its opportunity cost.

An estimate of the level of additional returns beyond the cost of capital that will satisfy farmers in their investment is also necessary. A farmer will not borrow money at 15 percent interest rate if he expects a return of 15 percent. CIMMYT (1988) estimates a 50 percent minimum, 50 percent if the technology being recommended represents only an adjustment in current farmer practice, as in increasing the rates of fertilizer use from 40 kgs to 60 kgs; 100 percent minimum rate of return if it is a new technology, as in the case of intercropping vs. monoculture; and above 100 percent rate of return, a safety level of recommendation. The recommendation domain should nevertheless consider the period of crop cycles and inflation rate. Accordingly, the 50-100 percent range are applicable to crops with cycles of 4-5 months, and it should be above 100 percent with crops of larger yields.

It should be noted further that farmers will continue to invest if the marginal rate of return are higher than the marginal costs.

#### **4.4 Residual Analysis.**

The results of a marginal analysis can be checked by the so-called residual analysis. CIMMYT (1988) used the term "residual" to indicate the difference between the net benefits and the costs of investment. It is calculated by subtracting the returns that farmers require (the minimum rate of return multiplied by the total variable cost) from net benefits. The technology with the highest residual should be considered. In the coconut cropping pattern experiments, the residual analysis indicate that coconut + blackpepper gives the maximum residual which confirms the results of the marginal analysis where the same cropping pattern also resulted in the highest MRR (Table 11).

In the selection of the technology for recommendation to farmers, a dominance analysis could be done first, followed by the marginal analysis and checking the results by the residual analysis. The dominance analysis facilitates the decision by eliminating technology (ies) with lower benefits.

#### **4.5 Sensitivity Analysis.**

Yields, input and product prices are subject to change and this affects the returns to farm investment. Yields may vary due to uncertainties in weather conditions. Input and product prices are affected by inflation, government price intervention (usually in the form of price controls and subsidies), and in the case of export crops output prices fluctuate because of instabilities in the world market. In partial and complete budget analysis, the variability of these factors should be taken into account and hence, in making recommendations to farmers as these also affect their decisions.

If prices fluctuate yearly, average prices for the past 3 to 5 years maybe used in the determination of field output price. Or a price trend analysis for 10 years maybe utilized.

One of the suggested test of a technology recommendation in relation to price changes is

**Table 10. Marginal Analysis, Different Cropping Patterns Under Coconut**

Cropping Pattern	Total Variable Costs	Marginal Costs	Net Benefits (P/ha)	Marginal Net Benefits	MRR (%)
1. Coconut alone	1,599.29		3,851.09		
		158.42		354.86	224.00
2. Coconut = bpepper	1,757.71		4,205.95		
		1,095.79		102.98	9.40
4. Coconut = bpepper = pineapple = papaya	2,853.50		4,102.97		
		627.50		1,110.74	177.00
			5,213.71		
5. Coconut = bpepper = cocoa	3,481.00				
		1,722.80		1,012.62	58.80
			6,226.33		
6. Coconut = bpepper = pineapple = cocoa	5,203.80				

**Table 11. Residual Analysis, Different Cropping Patterns Under Coconut**

Cropping Pattern	(1) Total Variable Costs	(2) Net Benefits (P/ha)	(3) Return Required [100%x(1)]	(4) Residual [(2)-(3)]
1. Coconut alone	1,599.29	3,851.09	1,599.29	2,251.80
2. Coconut + bpepper	1,757.71	4,205.95	1,757.71	2,448.24*
4. Coconut + bpepper + pineapple + papaya	2,853.50	4,102.97	2,853.50	1,249.47
5. Coconut + bpepper + cocoa	3,481.00	5,213.71	3,481.00	1,732.71
6. Coconut + bpepper + pineapple + cocoa	5,203.80	6,226.33	5,203.80	1,022.53

\* Maximum residual.

**sensitivity analysis.** In this type of analysis, alternative input and product prices are used in the calculation of the value of production (or gross returns) and production costs. It implies redoing a marginal analysis. To use a simple illustration, consider a change in the price of herbicide in Table 3. A 30 percent increase in the price of herbicide (from P250 to P325/liter) will result in a corresponding increase in cost of herbicide use (P325/liter x 2 liter/ha) from P500/ha to P650/ha. Assuming all other input costs and product price constant, net benefits of herbicide application would decrease from P3,720/ha to P3,570/ha. Redoing a marginal analysis would result in marginal rate of return of 1.49 or 149 percent which is a reduction from the initial MRR of 269 percent.

The above example implies a change in the economic interpretation of the results and maybe farmers recommendation and their decisions. Because of the input price increase, will the recommendation include a reduction in the level of herbicide application, a reduction in yields or output, and in terms of farmers acceptance if the computed MRR is within the minimum acceptable returns expected by the farmers.

## **5. Conclusions**

Marginal analysis in partial budgeting provides an assessment of the expected additional returns or benefits in relation to the added costs. This type of economic analysis is usually applied in on-farm research trials and their subsequent recommendations to farmers. The procedures could very well apply in the selection of the profit maximizing multi-crop combination or crop-livestock farming combination in coconut-based farming systems. The procedures described in this paper and the analyses of the results of the examples used have only considered current market values, i.e. current prices. As perennial crops like coconut and some of the intercrops (e.g. cocoa, coffee, blackpepper) have long period durations, the net present values of the income generated over the period should also be considered in the analysis.