Foundations of Accounting & Finance

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Lecture – 36

Decision Making using Cost Accounting Information - Examples - Part V

Example seven (product mix decision with a constraint)

A company running an orchard, with an adequate supply of labour, presents the following data and requests your advice about the area to be allotted for the cultivation of various types of fruits, which would result in the maximization of profits. The company contemplates growing Apples, Lemons, Oranges and Peaches.

	Apples	Lemons	Oranges	Peaches
Selling price per box (Rs)	15	15	30	45
Season's yield in boxes per acre	500	150	100	200
Cost: Material per acre (Rs)	270	105	90	150
Labour: growing per acre	300	225	150	195
Picking and packing per box	1.5	1.5	3	4.5
Transport per box	3	3	1.5	4.5

The fixed cost in each season would be:

The following limitations are also placed before you:

(a) The area available is 450 acres, but out of this 300 acres are suitable for growing only Oranges and Lemons. The balance of 150 acres is suitable for growing any of the four fruits viz., Apples, Lemons, Oranges and Peaches.

(b) As the produce may be hypothecated to banks, area allotted for any fruit should be demarcated in complete acres and not in fractions of an acre.

(c) The marketing strategy of the Company requires the compulsory production of all the four types of fruits in a season and the minimum quantity of any one type to be 18000 boxes.

Solution

Selling price per box

Let us return to the excel sheet and list the four types of fruits: apples, lemons, oranges, and peaches. We will begin by recording the selling price per box for each fruit.

Selling price per box:

- Apples: $15
- Lemons: $15
- Oranges: $13
- Peaches: $45

Our primary objective is to maximize revenue. However, we must consider the presence of fixed costs, such as transportation, cultivation, and land revenue taxes. These fixed costs are inevitable and will be incurred regardless of the type or quantity of fruit grown.

For example, transportation costs include vehicle depreciation, which is an essential aspect of transportation. Similarly, cultivation and growing expenses, as well as land revenue taxes, are unavoidable fixed costs.

Therefore, regardless of the combination or quantity of fruits grown, these fixed costs will remain constant. Our initial focus is to maximize the contribution per fruit or per box, ensuring that each box's contribution helps cover these fixed costs.

Yield per acre

To calculate the contribution, we need to consider the yield per acre for each type of fruit. The yield per acre is as follows: 500 boxes for apples, 150 boxes for lemons, 100 boxes for oranges, and 200 boxes for peaches.

Our objective is to maximize the contribution per acre. While it is true that maximizing contribution per box is important, we must also account for the varying yields per acre for different types of fruits. For instance, while oranges may have a high contribution per box, their lower yield per acre compared to apples could impact the overall contribution per acre.

Therefore, our objective function is to maximize revenue or contribution per acre. Let us proceed with this approach and calculate the contribution per acre for each type of fruit.

Material cost per acre and box

To calculate the contribution per box, we will consider the material cost per box for each type of fruit. The material cost per acre is given as follows: $270 for apples, $105 for lemons, $90 for oranges, and $150 for peaches. The material cost per box is calculated by dividing material cost per acre with yield (number of boxes) per acre. This amounts to 0.54 , 0.7, 0.9 and 0.75

Labor growing cost per acre and box

Similarly, labour cost per acre is given as follows: $300 for apples, $225 for lemons, $150 for oranges, and $195 for peaches. The labour cost per box is calculated by dividing labour growing cost per acre with yield (number of boxes) per acre. This amounts to 0.60 , 1.50, 1.50 and 0.98.

Picking and packing and transportations per box

The next aspect we are considering is the picking, packing, and transportation costs per box. Picking and packing per box are estimated at 1.5, 1.5, 3.0, and 4.5, while transportation costs per box are 3.0, 3.0, 1.5, and 4.50. With these variable costs identified, we can proceed to calculate the contribution per box

Total variable cost per box

The contribution per box is obtained by subtracting the total variable cost from the selling price per box as indicated below:

	Apples	**Lemons**	**Oranges**	**Peaches**
Selling price per box	15.00	15.00	30.00	45.00
Yield per acre no of boxes	500	150	100	200
material cost per acre	270.00	105.00	90.00	150.00
material cost per box	0.54	0.7	0.9	0.75
labor growing cost per acre	300.00	225.00	150.00	195.00
labor growing cost per box	0.60	1.50	1.50	0.98
picking and packing per box	1.50	1.50	3.00	4.50
transportation per box	3.00	3.00	1.50	4.50
Total variable cost per box	5.64	6.70	6.90	10.73
Contribution per box	9.36	8.30	23.10	34.28
ranking based on contribution per box	3	4	2	1

Ranking based on contribution per box

Typically, if we rank based on the highest contribution per box, I would say peaches are number 1, followed by oranges, apples, and then lemons. However, there is a constraint: oranges and lemons. So, among these two, I will grow more oranges because oranges yield higher contribution per box. Similarly, among apples and peaches, I will prioritize peaches because they yield higher contribution per box.

But what is our objective? Our objective is to maximize revenue per acre, not per box, because the yield in boxes varies. So, let us look at contribution per acre.

Contribution per box	9.36	8.30	23.10	34.28
ranking based on contribution per box	3	4	2	1
Contribution per acre	4680	1245	2310	6855
ranking based on contribution per acre	2	4	3	1

Contribution per acre is determined by multiplying the contribution per box by the number of boxes obtained per acre. Our objective function in this case is to maximize this value, as it represents contribution per acre.

Now, you can see that the ranking differs. For example, if I rank solely based on contribution per box, peaches would be number 1, oranges number 2, apples number 3, and lemons number 4. This is the ranking based on contribution per box. However, if the yield were exactly the same for all types of fruits, then I would use this ranking to maximize contribution per box.

Objective function

My objective function is to maximize my contribution per acre because yields vary per acre. So, when I rank based on contribution per acre, peaches become number 1, apples become number 2, oranges become number 3, and lemons become number 4. You can see that the rankings for 2 and 3 change.

Now, what if there were no constraints? If the entire 450 acres could be used for any type of fruit, I would choose to manufacture only peaches.

However, with the minimum constraint of 18,000 boxes that must be manufactured, I will ensure that this minimum criterion is met. Then, I will allocate the rest of the acreage to manufacturing only peaches.

If there is a maximum limit constraint on the number of peach boxes I can manufacture, I will consider switching to growing apples if necessary. But in this case, there are constraints to consider.

What is the constraint?

The constraint in this problem is that 300 acres are designated for growing only oranges and lemons, leaving the remaining acres available for growing other fruits, such as apples and peaches. The objective is to maximize the contribution per acre.

To meet the minimum requirement of growing 18,000 boxes, calculations are made to determine the necessary acreage based on the yield per acre for each fruit. For example, if the yield for oranges is 500 boxes per acre, then 36 acres are needed to grow 18,000 boxes of oranges.

Considering the total available acres (450) and the acres utilized for oranges and lemons (300), the remaining acres available for growing other fruits is calculated. In this case, 24 acres are available, which are allocated to growing peaches.

The total contribution is calculated by multiplying the number of acres allocated for each fruit by the contribution per acre for that fruit. For instance, if 36 acres are allocated for oranges and the contribution per acre is $4,680, then the total contribution for oranges is $168,480.

Fixed cost

The total fixed costs encompass cultivation, growing, picking and packing, transport, administration, and land revenue. The total fixed cost amounts to $210,000.

Overall profit or loss

So, what is my overall profit or loss? It will be the total contribution minus the fixed cost, representing my overall profit or loss in this particular case amounting to $13,05,150. This is the maximum profit or loss achievable in this scenario. Whatever combinations you try; this is the maximum profit you can obtain. Given these constraints, I am maximizing the per-acre contribution, determining the product mix that yields this result.

min acre for growing 18000 boxes	36	120	180	90	426
acres used for orange & Lemon min qty					300
acre available for choosing the fruit with max contribution					24
excess acres allocated to				24	
total acres allocated for each fruit	**36**	**120**	**180**	**114**	**450**
total contribution	1,68,480	1,49,400	4,15,800	7,81,470	15,15,150
Less fixed cost					
Cultivation and growing					56000
Picking					42000
Transport					10000
Administration					84000
Land Revenue					18000
total fixed cost					2,10,000
overall profit or loss					13,05,150

Example eight

PQ ltd has been offered a choice to buy a machine between A and B. You are required to compute:

a) Level of sales at which both machines earn equal profit.

b) Range of sales at which one is more profitable than the other.

Market price of the product is expected to be $ 10 per unit.

Machine	A	B
Annual output in units	10,000	10,000
Fixed cost	$ 30,000	16,000
Profit at above level of production	$ 30,000	24,000

Solution

First, let us determine the fixed cost. The fixed cost of each of these machines is $30,000 and $16,000 respectively, as provided in the problem.

Now, let us calculate the total cost. Total cost is the sum of fixed cost and variable cost. For machine A, it is $30,000 plus variable cost, and for machine B, it is $16,000 plus variable cost.

The price is $10 per unit for both machines, with an annual output of 10,000 units each. So, the total sale value is the price per unit multiplied by the number of units sold amounting to $100,000 in both cases.

The profit is given as $30,000 for machine A and $24,000 for machine B. To calculate the variable cost, we subtract the profit from the total sale value, and then subtract the fixed cost per unit to find the variable cost per unit.

Once we have the variable cost per unit, we can calculate the contribution per unit by subtracting the variable cost from the selling price.

Finally, let us compare the fixed costs between the two machines. The difference in fixed cost is $14,000.

a) Level of sales at which both machines earn equal profit

Now, what is the objective function here? The objective function here is that the total cost has to be the same for both machines.

That is the essence of the first question, determining the level of sales when both machines make equal profit. The total cost must be equal for both machines at this level of sales. In other words, we are looking for the level of sales where the total cost is the same for both machines. Let us denote this level of sales as Z.

Now, let us calculate the total cost for each machine at Z units. For machine A, it is $30,000 (fixed cost) plus $4 (variable cost per unit) times Z (number of units). For machine B, it is $16,000 (fixed cost) plus $6 (variable cost per unit) times Z.

We can solve for Z by setting up and solving a simple simultaneous equation. When you solve for Z, you will find that Z equals 7,000 units. At this level of sales, the profit for both machines will be equal.

Proof

Now, to prove this, let us consider the scenario where both machines produce 7,000 units. The total contribution for machine A is $4 times 7,000 units ($42000) , and for machine B , it is $6 times 7,000 units ($28,000). The fixed costs remain the same for both machines.

The level of sales at which both machines earn the same profit is 7,000 units.

b) Range of sales at which one is more profitable than the other

Now, let us determine the range of sales where one machine is more profitable than the other. We can do this by comparing their contributions. The difference in fixed costs between the two machines is $14,000. If we divide this by the difference in contribution per unit, which is $2, we get 7,000 units.

So, if the level of sales is above 7,000 units, machine A is more profitable. If it is below 7,000 units, machine B is more profitable.

Understanding this helps us decide which machine to buy based on our production volume. If our volume is high, say 20,000 or 30,000 units, we would choose machine A. But if we are operating on a smaller scale, say 5,000 units, machine B might be the better choice.

	A	B	diff
fixed cost	30,000	16,000	14,000
Total cost	30000+VC	16000+VC	
number of units currently manuf	10,000	10,000	
price per unit	10	10	
total sale value	1,00,000	1,00,000	
profit	30000	24000	
Total variable cost	40,000	60,000	
variable cost per unit	4	6	
Contribution per unit	6	4	
total cost has to be same for both at what level of sale			
assume the level sale where the total cost is the same for both to be 'Z'			
total cost for the machine at Z units	30000+4Z	16000+6Z	
solve for Z	7000		
at 7000 units the profit for both the machines will be equal			
no of units	7000	7000	
contibution total	42000	28000	
fixed cost	30,000	16,000	
profit	12,000	12,000	