Chapter 7
FARM EFFICIENCY

7.1 INTRODUCTION

7.1.1 In our fifth chapter we have given a detail account of input use and output raised in our sample economy in a very simple manner. In that chapter we have used the concepts like output-input ratio, home labour co-efficient, various yield rates, farm-size productivity, etc. to measure input use efficiency in a very crude aggregate manner. In the sixth chapter we have used both the Linear and Log-linear regression functions to clarify the input responses on output of total as well as individual crops. Both the attempts are in aggregative in nature and they did not provide any information about the farm efficiency at individual level. In this chapter we like to test the farm efficiency at individual level by using the **Data Envelopment Analysis (DEA) Technique**, occasionally called the **Frontier Analysis**.

7.1.2 It is, in order in analyzing relative efficiency, to mention the names of the authors like Debreu (1951), Koopmans (1951) and Farrell (1957, models for evaluating productivity) who for the first time understood and elaborated the concept of relative efficiency. However, as a mathematical programming DEA technique, although based on earlier work of Ferrell, has been used by the researchers in a number of fields since its inception in the year 1978 by Charnes , Cooper and Rhodes (CCR)) and further generalized by Banker, Charnes, and Cooper (BCC) (1984). It is an important non-parametric method of evaluation. Using a sample of actually observed input-output data, it derives a benchmark output quantity with which the actual output of an individual firm can be compared for efficiency measurement. In their originating article Charnes, Cooper and Rhodes (CCR) described DEA as a "mathematical programming model applied to observational data (that) provides a new way of obtaining empirical estimates of relations- such as the production functions and/or efficient production possibility surfaces- that are cornerstones of modern economics". DEA is a methodology directed to frontiers rather than central tendencies as in the case of regression.

7.1.3 To test the relative efficiency of the farms of our sample villages we have made some modifications according to our object and according to our data. We have also made some assumptions to justify our findings. They are:

- the farmers will use their land throughout the agricultural year;
- they will produce three crops viz. Aman paddy, Potato and Boro paddy;
- existing technology mix will be used in the production process;
- there will be no input market and output market constraints;
- agricultural crop year should be a normal crop year;
- agricultural production will be indifferent of size of the farms;
- farms that will produce three above mentioned crops be termed as objective farms.
- farms are relatively efficient when they are able to use the appropriate combinations of different inputs for producing the required amount of output.

7.1.4 There are 33 farms out of 121 farms that have successfully raised three crops namely Aman paddy, Potato and Boro paddy during the last agricultural year. Thus according to our apparent measure these 33 farms are objective farms. Now we are in a position to make a comparative performance assessment among the farms by using the DEA technique. Under this technique each of the 33 farms are regarded as the 33 Decision Making Units (DMUs) and we measure the relative efficiency of each DMU within the sample. In order to calculate the efficiency of a particular DMU we have used mathematical programming techniques to determine the relative value of the various outputs and inputs that maximizes a specific DMU's efficiency score with the assumption that a particular DMU may utilize any combination of inputs and outputs in order to maximize its own efficiency score subject to the constraint that all other DMU's efficiency scores using the particular DMU's weights are less than or equal to one. It is important to note that DEA models produce only relative efficiency scores in comparison to all other DMUs

7.2 EFFICIENT AND INEFFICIENT FARMS IN USING INPUT COMBINATIONS

7.2.1 According to our measure, a DMU is said to be relatively efficient when it is able to use the appropriate combination of different inputs for raising the required level of output of a particular crop and its efficiency score will be 1. It simply means that the input combinations are properly utilized to raise the required level of output by that particular DMU. Thus in case of efficient DMUs, the differences between the amount of input actually used (**Score Data**) and the required amount (**Projection**) will be zero for all the inputs. On the other hand, the inefficient DMUs are those who fail to use their input combinations appropriately in raising the required level of output and the efficiency scores for them will be less than 1. For the relatively inefficient DMUs, the differences between the score data and projected data for all/some inputs will be either positive or negative. In this way we have measured farm's relative efficiency for the above mentioned crops.

Table 7.1: INPUT USE EFFICIENCY

Crops	Total DMUs	Efficient DMUs		Inefficient DMUs	
		Number	Percentage	Number	Percentage
Aman Paddy	33	21	63.6	12	36.4
Potato	33	18	54.5	15	45.5
Boro Paddy	33	26	78.8	07	21.2

7.2.2 Apparently one can have an idea about the DMU's relative efficiency and in-efficiency from table 7.1. It appears from this table that DMUs of this area economy are mostly efficient in Boro paddy production. On the other hand, DMUs are least efficient in the production of potato. We have taken the farm data for a particular agricultural year. This kind of cross-sectional data often tempered by the input and output market shocks. Normally, the farmers of this grass-root area are very much efficient in potato production. This relative inefficiency may be due to the so called Cob-Web that exists in the agricultural price-output conjecture. Another important cause of this type of relative inefficiency in case of potato production is the unavailability of good quality seeds in this grass-root economy. Again, in case of Aman Paddy the farmers of this region are efficient by tradition as it is the main agricultural crop of this region.

7.3 EFFICIENCY SCORES AND RANKS OF THE DMUs FOR DIFFERENT CROPS

7.3.1 We have an opportunity to exhibit the efficient DMUs according to their ranks in case of Aman paddy. We ranked the DMUs in bottom-top approach. So the DMU named as V_1 is relatively lower farm in our farm ranking. According to our programming result, the 30^{th} DMU has been appeared as the most efficient DMU in case of Aman paddy production. Although we have chosen the DMUs haphazardly among the farms, but what remains to say is that the DMUs of the relatively lower land Group are most efficient as they occupied the ranks 2^{nd} to 8^{th} in the ranking table. On the other hand, ranking of the inefficient DMUs is given in table 7.3. In comparison of tables 7.2 and 7.3 we can simply say that the relatively smaller farms are efficient and relatively bigger farms are inefficient in this sample economy.

Table 7.2: EFFICIENT DMUs BY RANKS (AMAN PADDY)

Rank	DMU	Score
1 (1^{st})	V_{30}	1
1 (2^{nd})	V_1	1
1 (3^{rd})	V_2	1
1 (4^{th})	V_3	1
1 (5^{th})	V_4	1
1 6^{th})	V_5	1
1 (7^{th})	V_6	1
1 (8^{th})	V_7	1
1 (9^{th})	V_{25}	1
1 (10^{th})	V_{21}	1
1 (11^{th})	V_{10}	1
1 (12^{th})	V_{11}	1
1 (13^{th})	V_{20}	1
1 (14^{th})	V_{13}	1
1 (15^{th})	V_{14}	1
1 (16^{th})	V_{19}	1
1 (17^{th})	V_{16}	1
1 (18^{th})	V_{17}	1
1 (19^{th})	V_{24}	1
1 (20^{th})	V_{33}	1
1 (21^{st})	V_{32}	1

Table 7.3: INEFFICIENT DMUs BY RANKS (AMAN PADDY)

Rank	DMU	Score
22	V_{15}	0.998358
23	V_{22}	0.998045
24	V_{9}	0.99534
25	V_{28}	0.990175
26	V_{12}	0.985795
27	V_{26}	0.984847
28	V_{31}	0.974961
29	V_{18}	0.967736
30	V_{8}	0.963531
31	V_{29}	0.952446
32	V_{27}	0.93982
33	V_{23}	0.909862

7.3.2 We have also constructed table 7.4 where the reasons of inefficiency are self explanatory. But what remains to say is that out of 12 inefficient DMUs, 5 DMUs can be converted into efficient DMUs if these DMUs can use their home labour, organic manure and insecticides in a little bit efficient manner. If this is so then the number of relatively efficient DMUs becomes 26 out of 33 DMUs. Thus the manner of management of inputs at this grass-root level economy appears as an important factor subject to the fulfillment of other assumptions.

Table 7.4: INEFFICIENT DMUs WITH REASONS (AMAN PADDY)

DMU	Score	Excess DEP S-(1)	Excess HOMLA S-(2)	Excess HILA S-(3)	Excess SEE S-(4)	Excess ORGM S-(5)	Excess INORGM S-(6)	Excess INSEC S-(7)
V_{8}	0.963	0	0	0	0	0	3.669	19.252
V_{9}	0.995	85.196	105.057	0	17.740	0	21.558	41.545
V_{12}	0.985	8.621	55.911	19.315	0	0	0	1.402
V_{15}	0.999	0	0	0	0	31.583	0	32.423
V_{18}	0.967	0	0	112.200	7.421	116.744	9.137	76.847
V_{22}	0.998	0	118.014	8.553	0	0	0	35.516
V_{23}	0.909	157.406	0	0	13.901	0	0	68.129
V_{26}	0.984	15.962	0	0	12.862	0	11.235	39.277
V_{27}	0.939	77.778	0	90.449	0	168.367	0	33.245
V_{28}	0.990	0	0	0	0	33.712	0	57.870
V_{29}	0.952	0	0	284.198	0	203.367	0	61.855
V_{31}	0.974	0	0	47.865	0	17.173	0	19.758

7.3.3 It will be in order if we consider the relative efficiency of the DMUs in case of potato production, the second crop of our efficiency parameter. Here, what we have seen in case of Aman paddy, we have obtained a rather opposite picture of DMU efficiency. In case of potato production, the DMUs of the relatively higher land group rank in a better position in comparison to the DMUs of the lower land holding group. This has become possible simply due to their relatively higher educational knowledge and economic capacity of providing the good quality inputs in time. However, four DMUs of the land group "up to 2 Acres" and four DMUs of the middle land group have succeeded to register themselves in efficiency table. Our special studies of farms reveal that out of these 8 DMUs, the owners of 5 DMUs are engaged in service, the owners 2 DMUs are engaged in business and have their own deep tube-wells for irrigation. So, the tale of success of these DMUs is remaining the same.

Table 7.5: EFFICIENT DMUs BY RANKS (POTATO)

Rank	DMU	Score
1 (1st)	V_{33}	1
1 (2nd)	V_{32}	1
1 (3rd)	V_{31}	1
1 (4th)	V_{3}	1
1 (5th)	V_{30}	1
1 (6th)	V_{28}	1
1 (7th)	V_{6}	1
1 (8th)	V_{7}	1
1 (9th)	V_{24}	1
1 (10th)	V_{9}	1
1 (11th)	V_{10}	1
1 (12th)	V_{11}	1
1 (13th)	V_{23}	1
1 (14th)	V_{22}	1
1 (15th)	V_{26}	1
1 (16th)	V_{27}	1
1 (17th)	V_{29}	1
1 (18th)	V_{13}	1

TABLE 7.6: INEFFICIENT DMUs BY RANKS (POTATO)

Rank	DMU	Score
19	V_5	0.997517
20	V_{14}	0.996106
21	V_8	0.992154
22	V_1	0.986051
23	V_2	0.985333
24	V_4	0.984336
25	V_{17}	0.981542
26	V_{20}	0.980515
27	V_{25}	0.978133
28	V_{15}	0.968134
29	V_{21}	0.965826
30	V_{16}	0.965151
31	V_{12}	0.964509
32	V_{18}	0.96114
33	V_{19}	0.958373

Table 7.7: INEFFICIENT DMUs WITH REASONS (POTATO)

DMU	Score	Excess DEP S-(1)	Excess HOM LA S-(2)	Excess HI LA S-(3)	Excess SEE S-(4)	Excess ORGM S-(5)	Excess INORGM S-(6)	Excess INSEC S-(7)	Excess IRRGWA S-(8)
V_1	0.986	0	3.292	40.065	0	0	199.724	44.462	253.187
V_2	0.985	0	242.337	0	0	86.482	112.303	0	164.035
V_4	0.984	0	0	0	122.242	0	58.026	49.132	219.841
V_5	0.997	22.302	6.739	0	0	0	40.063	59.864	0.387
V_8	0.992	90.783	64.094	0	181.072	83.362	91.587	0	11.904
V_{12}	0.964	4.833	104.075	0	0	230.763	56.542	58.861	217.051
V_{14}	0.996	0	538.084	0	114.091	0	47.691	67.412	282.675
V_{15}	0.968	5.325	96.491	0	95.866	363.966	66.721	30.226	0
V_{16}	0.965	0	71.979	0	94.853	201.965	37.670	11.625	0
V_{17}	0.982	38.172	101.739	0	0	274.059	93.471	36.095	0
V_{18}	0.961	0	214.051	0	50.105	119.505	47.177	0	0
V_{19}	0.958	33.363	127.256	0	0	377.361	0	32.223	0
V_{20}	0.981	0	343.626	0	105.155	127.029	1.345	0	0
V_{21}	0.965	0.841	17.398	0	0	217.520	81.816	21.232	0
V_{25}	0.978	10.709	0	107.935	105.052	141.699	90.319	37.479	5.182

7.3.4 One notices from table 7.6 that in case of raising potato the DMUs of the middle land group are mostly inefficient because they have failed to use the two most inexpensive inputs namely home labour and organic manure wisely in comparison to other DMUs. In an overall inspection it is apparently clear that all most all the DMUs in case of potato production used their home labour callously. One reason that might be justified this callous composition of input use is the absent of other competitive crops that would be raised in the same agricultural monsoon. One may also in temptation put forward the argument of lower opportunity cost of home labour.

7.3.5 One important point we like to mention here is that when at the time of investigation of completion of M. Phil Dissertation the investigator of this research enterprise accounted the existence of tobacco production in these two sample villages during the late 80s of the last century. But in the course of time and in the course of revisit the villages for Ph. D. Thesis the investigator surprisingly observes the absence of tobacco production and instead of tobacco the farmers of these sample villages have been inclined in the production of Boro paddy. This kind of shifting no doubt exhibits the positive outlook of the DMUs as of the illusory advantage of tobacco production (Sarkar and Kar, 1990).

7.3.6 Thus it will be interesting if we concentrate our looking in the relative efficiency of the DMUs in Boro paddy production. This is given in table 7.8. What we have noted in the preceding paragraph that can be justified through this table. Here out of 33 DMUs, 26 DMUs have been appeared as relatively efficient DMUs. But what is important to note here is that irrespective of farm size the DMUs are efficient in raising the Boro paddy in this area economy. This outcome, in a large extent can express the reason of disappearance of tobacco cultivation in this area economy.

TABLE 7.8: EFFICIENT DMUs BY RANKS (BORO PADDY)

Rank	DMU	Score
1 (1st)	V_{33}	1
1 (2nd)	V_1	1
1 (3rd)	V_2	1
1 (4th)	V_3	1
1 (5th)	V_{32}	1
1 (6th)	V_5	1
1 (7th)	V_{31}	1
1 (8th)	V_7	1
1 (9th)	V_8	1
1 (10th)	V_9	1
1 (11th)	V_{10}	1
1 (12th)	V_{11}	1
1 (13th)	V_{12}	1
1 (14th)	V_{13}	1
1 (15th)	V_{14}	1
1 (16th)	V_{30}	1
1 (17th)	V_{16}	1
1 (18th)	V_{28}	1
1 (19th)	V_{18}	1
1 (20th)	V_{19}	1
1 (21st)	V_{20}	1
1 (22nd)	V_{21}	1
1 (23rd)	V_{22}	1
1 (24th)	V_{23}	1
1 (25th)	V_{26}	1
1 (26th)	V_{25}	1

Table 7.9: INEFFICIENT DMUs BY RANKS (BORO PADDY)

Rank	DMU	Score
27	V_{27}	0.997531
28	V_4	0.996607
29	V_6	0.984669
30	V_{15}	0.978445
31	V_{29}	0.976736
32	V_{17}	0.974601
33	V_{24}	0.967014

Table 7.10: INEFFICIENT DMUs WITH REASONS (BORO PADDY)

DMU	Score	Excess DEP S-(1)	Excess HOMLA S-(2)	Excess HI LA S-(3)	Excess SEE S-(4)	Excess ORGM S-(5)	Excess INORGM S-(6)	Excess INSEC S-(7)	Excess IRRGWA S-(8)
V_4	0.996	0	34.662	0	7.897	0	5.219	17.661	26.084
V_6	0.984	0	0	24.170	14.105	0	0	0	0
V_{15}	0.978	83.637	29.097	66.156	0	0	6.935	8.241	0
V_{17}	0.974	0	0	76.046	18.764	0	0	0	0
V_{24}	0.967	0	0	152.468	1.887	0	0	11.643	89.962
V_{27}	0.997	55.274	0	55.893	7.399	26.799	0	49.621	1.596
V_{29}	0.976	51.423	0	32.607	0	0	0	6.842	0

7.3.7 The vertical size of the inefficient table bearing No. 7.9 tells us the tale of Boro paddy production in a very significant manner. If we have a look on the same table then we see that out of 7 inefficient DMUs, three DMUs can be converted into efficient DMUs just a little bit wise use of inputs as revealed from table 7.10.

7.3.8 The most interesting point to be mentioned here is that there are some common DMUs in different land groups (V_3, V_7 in the land group "up to 2 Acres"; V_{10}, V_{11}, V_{13} in the land group "2-4 Acres" and V_{30}, V_{31}, V_{32}, V_{33} in the land group "4 + Acres") which are equally efficient in producing all these three crops in comparison to other DMUs in our sample economy. Our observation during the field survey reveals that the farmers of these common efficient DMUs possess the required minimum educational and technical knowledge for agricultural activities and they have the capacity of using good quality inputs required for a particular crop in time. Thus to make this grass-root economy efficient in all agricultural activities, particularly in case of Ravi Crops, the Official Agencies at the Block or District level should arrange proper seasonal training with the farmers regarding better and appropriate input combinations and at the same time easy and cheap credit facility should be extended to them.