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# How Does Primary Dairy Cooperative Perform? A Study of Physical and Financial Performance Variables in West Bengal State in India

Research Article

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## ABSTRACT

This paper attempts to examine the physical and financial performance of some primary dairy co-operatives in west Bengal state in Indian context. The study suggests that financial performance indicators dominate over physical ones, and all the dominating variables have long term positive impact on primary milk producers' co-operative societies (PMPCSs). Also, the significant impact of financial performance variables contributes to high profit efficiency for all primary dairy co-operative societies under study. These results seem to suggest that in order to strengthen the dairy development programme on co-operative line at the primary level more emphasis should be given to these dominating physical and financial performance variables in general and physical dominating variables in particular.

KEY WORDS financial performance indicators, physical performance indicators, primary milk producers' co-operative societies, principal component analysis.

## INTRODUCTION

Dairy industry has made significant progress in India during the recent years. The dairy sub-sector occupies an important place in agricultural economy of India as milk is the second largest agricultural commodity contributing to gross national product (GNP), next only to rice. The percentage share of livestock sector in gross domestic product (GDP) is 4.36 in 2006-2007 in which the dairy sub-sector contributes 68.55 percent of total value of livestock products during 2006-2007.

As compared with 1998-1999 figures, milk production in India has increased by about 40 percent in 2007-2008. Most importantly, dairy cooperatives account for the major share of processed milk in the country during 2007-2008 (NDDB, 2007). The breakthrough is due to successful implementation of operation flood (OF) programme through the national dairy development board (NDDB, 2007) which developed co-operative model in the country in July 1970, with the objective of laying the foundation for a modern dairy industry, which could meet the country's need for processed milk and milk products. The first phase of OF was aimed at capturing liquid milk in four metropolitan cities by linking 27 milk sheds. During 1980-1985 the programme of the second phase of OF was extended to all the states of the country. As a result, about 34500 dairy co-operative societies had become organized under 136 milk sheds. Government outlay on developing the livestock sector, animal husbandry and dairying, rose dramatically from a mere 2324 million rupees in the fifth plan (1974-1978) to a total outlay of 8025 million rupees in the sixth plan (1980-1985), of which 4363 million rupees were meant for expenditure on dairying alone. During 1985-1994, the OF-III aimed primarily at consolidating the extensive milk procurement and marketing system established during the second phase.

As regards government outlay is concerned, during the seventh plan (1985-1990), 4935 million rupees were earmarked for dairying out of total outlay of 11348 million rupees for animal husbandry and dairying. Expenditure on dairying increased sharply during the eighth plan (1992-1997). Of the total outlay of 1300 million rupees the proposed expenditure on dairying was nearly 70 percent. Such increased allocation in plan outlay is a reflection of the importance of draying in government's overall policy encompassing country's agricultural economy.

However the successful implementation of different programmes on dairying in India have established 128799 organized district co-operative societies in 23 states including union territories and has marketed 18921 thousand liter per day (TLPD) by making 13411000 farmers their members during 2007-2008 (Ibid).

The success of operation flood programme motivated the government for an integrated dairy development programme (IDDP) in different areas to enhance production, procurement, processing and marketing of milk for generating income and employment opportunities to those areas (Sandeep, 2005). The national policy of co-operative (NPC) of government of India has also sought to encourage the co-operatives to grow as self-reliant grass roots democratic institutions owned, managed and controlled by members. But the growth of dairy co-operatives in some states like Gujarat, Maharashtra, Tamilnadu and Karnataka has brought about more economic betterment and well being of the rural population compared with other states like Bihar, Orissa and Andhra Pradesh (Benni, 2005). However, as a later starter, West Bengal co-operative milk producers federation limited (WBCMPFL) started its journey on and from 1983 under the debut of government of West Bengal following three tier structure of Anand pattern of milk co-operatives: WBCMPFL at the state level, district milk union (DMU) at the district level and primary milk producers' co-operative societies (PMPCS) at the village level. As compared with all India figure, West Bengal places 12$^{th}$ position in production (in tons) among all states in India by contributing only 3.90 percent of total production in 2007-2008. West Bengal has established 12678 organized district co-operative societies (cumulative) -2.08 percent of all India figure and has marketed 673 TLPD -3.56 percent of all India figure by incorporating 66000 farmers (about 0.5 percent of India's figure) as their members during 2007-2008 (NDDB, 2007). Per capita availability of milk (128 g/d) for West Bengal is much lower than all India data (252 g/d). Similarly, there are hardly studies which examine the physical and financial performance of these primary co-operative societies in West Bengal. However some efforts have been made to examine the physical and financial performance of dairy co-operatives in India (Benni, 2005; Rangasamy, 2001; Malik, 1989; Pundir, 1998; Ram and Singh, 1987; Chauhan, 1987; Rangasamy, 2007). Based on the study of 12 primary dairy co-operative societies in Saurashtra state during 1986-1987 to 1991-1992, observed that the financial indicators played a vital role in the performance of dairy co-operatives as their weight-age calculated from principal component analysis was nearly three times that of the physical indicators.

The present paper, however, attempts to examine the physical and financial performance of some primary dairy co-operatives in West Bengal. The underlying hypothesis are that i) financial performance indicators of primary co-operative societies dominate over physical ones, and all the dominating variables have long term positive impact on PMPCSs. ii) the significant impact of financial performance variables contributes to high profit efficiency for all primary dairy co-operative societies under study.

## MATERIALS AND METHODS

### Data set and methodology

The three tier structure of the dairy co-operatives in West Bengal is WBCMPFL at the state level (an apex body of milk co-operatives in the state of West Bengal), DMU at the district level (a representative body of village societies) and PMPCS at the village level.

In order to select four PMPCSs the following procedure is used. Under the WBCMPFL, there are 14 DMUs. Out of these, two DMUs are selected in the state: one is the highest performance based on the simple arithmetic mean of daily average milk production and daily average milk marketing (both measured in kilograms) and the other, the lowest of the same.

Two PMPCSs at the village level under each DMU is selected based on the same selection principle of each DMU. Four PMPCSs for final survey are Rukunpur-Balarampara primary milk producers' co-operative society Ltd. (RPMPCS), Farashdanga primary milk producers co-operative society Ltd. (FPMPCS), Khar-Radhakrishnapur primary milk producers' co-perative society Ltd. (KPMPCS), Sonepur primary milk producers' co-operative society Ltd. (SPMPCS).

The data pertaining to the performance of dairy co-operatives were collected for each PMPCS during the period from 1997-1998 to 2006-2007. In order to achieve the stated objectives of this study, the following methodology is used:

### i) Descriptive statistics

Descriptive statistics like mean, standard deviation, range, skewness and kurtosis are used here to assess the simple summaries about the sample regarding the performance of

various physical and financial indicators of dairy co-operatives. They have been used to convey the estimated magnitude and direction of the difference between groups, without regard to whether the difference is statistically significant. Also important is that different characteristics of descriptive statistics like mean, standard deviation of each variable have been used separately so that one may compare between different variables based on the results of same characteristics of each individual variable. Percentage analysis and calculation of index have been also used to assess the performance of various physical and financial indicators of dairy co-operatives. Higher values of both physical and financial indicators represent higher performance in all cases. The physical and financial performance indicators contain the following variables:

1. Average membership functioning in the selected PMPCSs ($X_1$).
2. Milk procurement per day in liter ($X_2$).
3. Average sale of cattle feed per sample PMPCS per year ($X_3$).
4. No. of artificial insemination (AI) cases per sample PMPCS per year ($X_4$).
5. The value of fixed assets ($X_5$) which includes all the long term assets in PMPCS such as land, buildings, machinery, transport equipments etc in the particular year.
6. The value of current assets ($X_6$) which includes all the short-term assets in PMPCS, which can be normally converted, back into cash quickly.
7. The value of total assets ($X_7$) which includes fixed assets, current assets and other assets. Total assets are positive factors of PMPCS.
8. Current liabilities ($X_8$) contain all the short term liabilities of PMPCS, repaid within one year. No long term loan was reported from PMPCS during study period.
9. Share capital ($X_9$) which are payable to creditors.
10. Reserve and surplus fund ($X_{10}$) are also payable to creditors.
11. Government grant in aid ($X_{11}$) per year.
12. Value of total milk purchased ($X_{12}$) per year by PMPCS from the members of the PMPCS.
13. Value of cattle feed (CF) purchased ($X_{13}$) per year by PMPCS for the members of the PMPCS.
14. Value of total purchases ($X_{14}$) per year, which includes milk, CF, milk products and others.
15. Value of milk sold to DMU ($X_{15}$) per year.
16. Value of milk sold to local area ($X_{16}$) per year.
17. Value of total sale per year ($X_{17}$), which includes milk, CF and milk product.
18. Value of total expenditure ($X_{18}$), which includes those costs that relate directly to the revenue of PMPCS and to the time period covered by the accounts such as staff salaries for the period etc.
19. Value of depreciation ($X_{19}$) per year on fixed capital.
20. Gross profit ($X_{20}$) per year.
21. Net profit ($X_{21}$) per year.
22. Dividend and bonus paid per year ($X_{22}$).

Significantly, two important aspects of financial performance indicators of PMPCSs need some clarifications for measuring the achievements of the particular issue. First all financial variables (eighteen) are usually categorized into eight economic factors: assets, liabilities, purchase, sales, depreciation, profit, dividend and grant in aid.

Assets: the 'assets' include a list of items owned by PMPCSs. The total asset contains fixed assets and current assets. Current assets contain all the short term assets in PMPCSs, which can be converted back into cash quickly, whereas fixed assets are expensive, long lasting physical items required for the operations of the business such as land, buildings, machinery and transport equipment. They also include long term holdings of shares in the other business organizations for trading purposes. Assets are positive factors of PMPCSs; more assets, the better would be the performance.

Liabilities: the various items of liabilities can be clubbed together in the following three headings a) current liabilities, b) long term loans and c) share capital, reserve and surplus fund. Current liabilities contain all the short term liabilities of PMPCSs. They are repaid within one year. No long term loan was reported from PMPCSs during the study period. Share capital, reserve and surplus funds are payable to creditors. Liabilities are negative factors of PMPCSs.

Purchase: one of the important functions of PMPCSs is the purchase of milk producers who are members of PMPCSs. Further, the purchase of cattle feed from them also constitute an important function of the PMPCSs. Similarly, the purchase of total milk per year, value of total purchase per year including milk, cattle feed, milk products and others are the important functions of the PMPCS. Purchase is positive factor of PMPCSs.

Sales: PMPCSs perform various sales activities. They purchase milk from members and sell it to the DMU and local area. They also sell cattle feed to the members. Thus, the PMPCSs set up relationship between member producers and milk consumes. Higher the positive value of the sales from purchase has more positive impact on PMPCSs.

Expenditure: lower expenditure with higher business turnover is a good positive indicator of growth and profitability of a particular organization. Total expenditure includes those costs that relate directly to the revenue of PMPCSs, to the time period covered by the accounts such as stuff salaries for the period and etc.

Depreciation: lower the magnitude of depreciation per sample PMPCSs is a good positive indicator of growth and profitability of the particular organization.

Profit: a large profit is the best indicator to measure performance of any organization. Higher the net profit of MPCSs has more positive impact on the health of PMPCSs.
Dividend paid: dividend is a return on investment. Members invest their assets for good profit. Profit and dividend depend upon the way in which assets of enterprises are utilized. An organization which uses their assets to the fullest extent is likely to receive higher profits and dividends.
Grant in aid: grant in aid usually paid by NDDB to the PMPCSs is also an important financial variable. Higher quantum of grant in aid to the PMPCSs in a long term basis usually does not lead to higher economic health of the PMPCSs. Second, it is worth mentioning that some individual elements are subsets of a particular element of indicator (for example fixed assets, current assets are subsets of total value of assets; the value of milk sold to federation and value of local sale including CF and milk product are subsets of value of total sells; net profit is the subset of gross profit and etc.) in the financial performance variables of the dairy co-operatives. The performance indicator includes both subsets and their pure set because they explore the relative economic importance regarding each PMPCS.

**ii) Principal component (PC) analysis**

Principal component method is a widely used approach for exploring some issues in empirical literature: obtaining factor loadings (weights), solving the problem of multicollinearity and assessing the reliability in the field of indices.

This study tries to identify the most important physical and financial performance indicators of PMPCSs to obtain factor loadings (weights) from principal component analysis, because each descriptive statistics, which reduces lots of data into a simpler summary (the typical scores, the variation of all scores of a particular variable from the typical score), cannot identify the most important physical and financial performance indicators of PMPCSs as principal component analysis does.

There is now a good number of studies in which factor loadings of first few principal components are used because latent root or eigen value obtained as sum of squares of the loadings of the first principal component absorbs and accounts for the maximum possible proportion of the total variation in the set of variables or indicators than the second principal component and so on (Mitra and Sinha, 2005; Khatun, 2001; World Bank, 2002). The method of principal component model which is employed to assess the magnitude of the most important physical and financial performance indicators influencing the performance of dairy co-operatives is exnressed as:

$$P_1 = a_{11}Y_1 + a_{12}Y_2 + \ldots\ldots + a_{1k}Y_k$$
$$P_2 = a_{21}Y_1 + a_{22}Y_2 + \ldots\ldots + a_{2k}Y_k$$
$$P_k = a_{k1}Y_1 + a_{k2}Y_2 + \ldots\ldots + a_{kk}Y_k$$
$$Y_j = (X_j - \bar{X}_j) / S_j$$

Where:
$Y_j$: standardized value of the $j^{th}$ indicators (j=1, 2, …k).
$X_j$: original value of the $j^{th}$ indicators.
$\bar{X}$: mean value of the $j^{th}$ indicators.
$S_j$: standard deviation of the $j^{th}$ indicators.
$P_i$: principal components (PCs) (i=1, 2, …, k).
$a_i$: loading values of the indicators.

These newly created variates (or variables) satisfy the following two conditions: 1) PCs are orthogonal linear function of the original value. 2) The first principal component ($PC_1$) absorbs and accounts for the maximum possible proportion of the total variation in the all Y. The second principal component ($PC_2$) absorbs the maximum of the remaining variation in the Y (often taking into account of the variation by $PC_1$) and so on.

This is due to the fact that the values of latent roots become smaller and smaller for subsequent principal components since the principal component procedure extracts the maximum possible for each principal component in turn.

According to descending order only the highest component variables were selected based on the principle that they account for substantial variation of Y. By this way the important variables which play important role in the variables based on the criterion of higher degree of closeness from the selected principal component variates in maximum number of years are selected in order of sequence.

**iii) Efficiency analysis**

**a) Year wise composite index analysis**

The performance indices / index of different societies can be developed on the basis of multivariate data to measure the level of development / performance of PMPCSs. Compared to the method of principal component analysis, this method is simpler without having the restrictive assumptions of linearity in the relationship of indicators. Iyengar and Sudarshan (1982) have developed an index based on multivariate data to measure the level of development of PMPCSs. Using Iyengar and Sudarshan (1982) method (without having the restrictive assumption of linearity in the relationship of indicators), performance indices $\bar{Y}_s$ of different societies were computed as under:

$\overline{Y}_s = W_1Y_{1s} + W_2Y_{2s} + \ldots + W_mY_{ms}$
$Y_{is} = (X_{is} - \text{Min } X_{is}) / (\text{Max } X_{is} - \text{Min } X_{is})$

Where:
i: 1, 2, 3,…, m.
s: 1, 2, 3,…, n.
$X_{is}$: value the $i^{th}$ performance indicator in the $s^{th}$ society.
$W_i$: arbi-trary weights reflecting the relative performance of the individual indicator.

$O < W_i < 1$ and $W_1 + W_2 + \ldots + W_m = 1$

However, a more rational view would be to assume that the weights vary inversely as the variation in the respective performance indicators. More specifically:

$$W_i = K \Big/ \sqrt{\text{Var}(Yi)}$$

$$K = \left[ \sum_{i=1}^{m} 1 \Big/ \sqrt{\text{Var}\ (Yi)} \right]^{-1}$$

The overall society index $\overline{Y}_s$ varies from zero to one. Also if $Y_1, Y_2, \ldots, Y_m$ are independent, then:

$$\text{Var}(Y_s) = \sum_{i-1}^{m} W_i^2 \text{Var}(Y_i)$$

Var ($Y_s$): constant and equal to $mK^2$ for all the societies.

The choice of the weights in this manner ensures that large variation in any one of the indicators will not unduly dominate the contribution of others indicators and distort inter society comparison.

**b) Efficiency analysis**

In econometric applications one specifies some explicit form of the production, cost, or profit function to represent the benchmark technology for efficiency measurement.

The maximum profit is the profit function underlying what may be considered as the best practice techniques utilized by a given group of firms. The interest of the sample firms (here, the PMPCSs) is focused on ascertaining the highest profit using the best practice technique at the firm level given the level of technology and the feasibility of input-output bundle chosen. We used two methods to analysis profit efficiency of the PMPCSs.

**1) Profit efficiency using data envelopment analysis (DEA)**

In econometric applications one specifies some explicitform of the production, cost, or profit function to represeent bench-mark technology for efficiency measurement. We also measure the profit efficiency of PMPCSs based on their financial performance indicators. The procedure of its measure is as follow: the method of data envelopment analysis introduced and further extended to non-constant returns technologies, provides a way to construct the production possibility set from an observed data set of input-output bundles.

Suppose that ($X_j$, $Y_j$) is the input-output bundle observed for firm j (j=1, 2,…, N). Clearly, these input-output bundles are all feasible. Then the smallest production possibility set satisfying the assumption of convexity and free disposability that includes these observed bundles is:

$$S = [(X, Y) : X \geq \sum_{j=1}^{N} \lambda\, jXj;\ Y \leq \sum_{j=1}^{N} \lambda\, jYj;\ \sum_{j=1}^{N} \lambda\, j = 1;\ \lambda\, j \geq 0;\ (j = 1,2,\ldots\ldots\ N)]$$

The set S is also, known as the free disposal convex hull of the observed input-output bundles. One can obtain various measures of efficiency of a firm using the set S as the reference technology.

For a commercial firm, both inputs and outputs will be choice variables and the only constraint the feasibility of the input-output bundle chosen. For such a firm, the criterion of efficiency is profit maximization. At input and output prices w and p, respectively, the actual profit of the firm producing the output bundle $Y^o$ from the input bundle $X^o$ is:

$$\Pi^o = p / Y^o - w / X^o$$

The maximum profit feasible for the firm is:

$$\Pi\ (w, p) = \max p / Y - w / X: (X, Y)\ \varepsilon T$$

In any empirical application, the maximum profit may be obtained as:

$$\Pi^* = \max p / Y - w / X_{st}$$

$$\sum_{j=1}^{N} \lambda jYj \geq Y;\ \sum_{j=1}^{N} \lambda jXj \leq X;\ \sum_{j=1}^{N} \lambda j = 1; \lambda j \geq 0; (j = 1,2,\ldots\ldots\ N)$$

The profit efficiency of the firm is measured as $\delta = \Pi^0 / \Pi^*$. This measure is also bounded between 0 and 1 except in the case where the actual profit is negative, while the maximum profit is positive. In that case δ is less than 0. If the maximum profit is negative as well, δ exceeds unity (Das *et al*. 2005).

**2) Profit efficiency using window analysis**

We also calculate the profit efficiency of PMPCSs under window analysis (Ramanathan, 2003). Window analysis is a moving average pattern of analysis and is described in Charness *et al.* (1985). A PMPCS in each period is treated as if it is a different PMPCS. The performance of a PMPCS is compared with its performance in other periods, in addition to comparing it with the performance of other PMPCS in the same period. We analyze 4 PMPCSs for the first five years, in total; we will have 20 PMPCSs since RPMPCS in year 1997-1998 is treated as a different PMPCS as compared to RPMPCS in year 1998-1999. Then the window is shifted by one year, and DEA analysis is performed for the four PMPCSs for the next five years and so on. This window type presentation facilities an easy comparison of the performance of a PMPCS over time as well as a comparison with its competitors at a particular point in time (Ramanathan, 2003).

## RESULTS AND DISCUSSION

**Descriptive statistics**

As mentioned earlier (data set and methodology), the performance of each PMPCS is influenced by twenty two variables which are grouped into two categories: physical performance indicators and financial performance indicators. Physical performance indicators and financial performance indicators for each PMPCS include 4 and 18 variables, respectively. Further, all financial variables have been categorized into eight economic factors: assets, liabilities, purchase, sales, depreciation, profit, dividend and grant in aid. The descriptive statistics for both physical performance indicators and financial performance indicators appear in Table 1 (combining all periods and all PMPCSs together). It shows that most of the financial indicators have high average values as comparable with physical indicators and the former has higher standard deviation (SD) values indicating that the absolute values of those financial indicators have wider variability around its average.

**Performance of indicators**

We now try to identify the most important physical and financial performance indicators of PMPCSs based on the principal component analysis.

The result of Table 2 shows that for all years under study (1997-1998 to 2006-2007), the first principal component ($PC_1$) absorbs and accounts for the maximum possible proportions of the total variations in the set of all Y, the second principal component ($PC_2$) absorbs the maximum of the remaining variation in the Y and so on. It also shows that the cumulative total of first three PCs (namely $PC_1$, $PC_2$ and $PC_3$) account for substantial variation (between 70 and 100 percent) of total, and the contribution of the remaining 19 PCs are insignificant. In order to select principle variables (important variables) out of all physical and financial variables from $PC_1$, $PC_2$ and $PC_3$, we consider relatively higher values of factor loadings (according to descending order) and the degree of closeness of the first factor loading values of each principal component (Table 3). It shows that the value of total purchase including milk products ($14^{th}$ performance indicator (PI)), total sell ($17^{th}$ PI), milk purchase ($12^{th}$ PI) and total milk procurement per day ($2^{nd}$ PI) are the principal variables in all years. The value of current assets ($6^{th}$ PI) and Govt. grant in aid ($11^{th}$ PI) are estimated as principal variables in 9 years and 8 years respectively. The dividends and bonus paid ($22^{nd}$ PI) and total depreciation ($19^{th}$ PI) appear as principal variables in 7 years; net profit ($21^{st}$ PI), share capital ($9^{th}$ PI) and total milk sell ($16^{th}$ PI) are in 4 years.

The number of AI cases ($4^{th}$ PI) is principal variables in 3 years; the value of fixed assets ($5^{th}$ PI), the value of total assets ($7^{th}$ PI) and total expenditure ($18^{th}$ PI) are estimated principal variable in 2 years.

Two variables, total number of membership ($1^{st}$ PI) and current liabilities ($8^{th}$ PI) have shown as principal variables only in 1 year. Table 3, however, suggests that in explaining the performance variation of functioning PMPCSs, the financial performance indicators dominate over physical performance indicators. Among financial indicators, value of total purchase, value of total sell, value of milk purchase, value of current assets, Govt. grant in aid, dividends and bonus paid, total depreciation, net profit, share capital and total milk sell are the most dominating principal variables. It implies that out of eighteen financial performance indicators ten variables are most dominating principal variables.

The most dominating financial variables which have been selected from principal component analysis are very important from economic point of view. As to the assets are concerned, only fixed assets, which requires long lasting physical items for the operation of PMPCSs, such as land, building, machinery, transport equipment, and long term holding of shares, are the most dominating principal variable.

Similarly, only share capital, which implies long term liabilities, not, usually, repaid within one year, is the dominating principal variable out of all variables of liabilities. Turning to the components of purchase, both sub-sets and pure-sets of the components of purchase (the value of total milk purchased and value of CF purchased are subsets of value of total purchase) are principal dominating variables.

**Table 1** Descriptive statistics for both physical and financial indicators

| Indicators | N | Range | Mean | SD | Skewness statistic | Kurtosis statistic |
|---|---|---|---|---|---|---|
| Average membership ($X_1$ ) | 40 | 772.00 | 357.25 | 287.78 | 0.272 | -1.716 |
| Milk procurement per day in lt. (X2). | 40 | 2424.90 | 719.92 | 695.38 | 0.937 | -0.020 |
| Average sale of cattle feed in kg.(X3) | 40 | 490500.00 | 138604.55 | 147713.35 | 0.885 | -0.442 |
| No. of artificial insemination (X4) | 40 | 1053.00 | 842.00 | 336.60 | 0.377 | -1.182 |
| Value of fixed assets (X5) | 40 | 392483.00 | 156363.42 | 109451.25 | 0.463 | -0.572 |
| The value of current assets (X6) | 40 | 2159940.00 | 534195.35 | 605329.06 | 1.002 | 0.031 |
| The value of total assets (X7) | 40 | 4753641.00 | 1190654.07 | 1349722.45 | 1.223 | 0.744 |
| Current liabilities (X8) | 40 | 3150377.00 | 573725.50 | 866630.73 | 2.032 | 3.361 |
| Share capital (X9) | 40 | 14730.00 | 3637.00 | 4737.96 | 1.724 | 1.550 |
| Reserve and surplus fund (X10) | 40 | 1350652.00 | 258984.35 | 434040.40 | 1.843 | 1.764 |
| Government grant in aid (X11) | 40 | 40000.00 | 4151.10 | 8288.24 | 3.072 | 10.292 |
| Value of total milk purchased (X12) | 40 | 8420106.00 | 2348252.05 | 2333482.13 | 1.054 | 0.325 |
| Value of cattle feed (CF) purchased (X13) | 40 | 3025384.00 | 752955.55 | 788810.60 | 1.036 | 0.567 |
| Value of total purchases (X14) | 40 | 9931094.00 | 3230095.22 | 3018726.86 | 0.677 | -0.710 |
| Value of milk sold to DMU (X15) | 40 | 8931930.00 | 2180212.95 | 2440544.45 | 1.352 | 1.007 |
| Value of milk sold to local area (X16) | 40 | 1654407.00 | 382966.80 | 464245.77 | 1.368 | 0.409 |
| Value of total sale per year (X17) | 40 | 10611867.00 | 3395017.15 | 3084510.64 | 0.580 | -0.914 |
| Value of total expenditure (X18) | 40 | 1402640.00 | 256267.85 | 293431.14 | 2.113 | 5.473 |
| Value of depreciation (X19) | 40 | 17190.00 | 6251.07 | 4496.97 | 0.826 | 0.515 |
| Gross profit (X20) | 40 | 679560.00 | 185747.22 | 182573.51 | 1.277 | 0.697 |
| Net profit (X21) | 40 | 402754.00 | 93361.70 | 112927.11 | 1.213 | 0.458 |
| Dividend and bonus paid per year (X22) | 40 | 108574.00 | 28216.45 | 32062.55 | 1.006 | -0.131 |

**Table 2** Total variance explained (eigen values) of first three principal components (PCs) for the years 1997-1998 to 2006-2007

| Years | Principal compnents (PCs) | Total variance | % of variance explained by Cs | Cumulative % |
|---|---|---|---|---|
| 1997-1998 | PC1 | 15.523 | 70.560 | 70.560 |
| | PC2 | 5.128 | 23.309 | 93.869 |
| | PC3 | 1.349 | 6.131 | 100.000 |
| 1998-1999 | PC1 | 16.212 | 73.689 | 73.689 |
| | PC2 | 5.286 | 24.028 | 97.717 |
| | PC3 | 0.502 | 2.283 | 100.000 |
| 1999-2000 | PC1 | 16.745 | 76.112 | 76.112 |
| | PC2 | 4.004 | 18.202 | 94.314 |
| | PC3 | 1.251 | 5.686 | 100.000 |
| 2000-2001 | PC1 | 16.680 | 75.820 | 75.820 |
| | PC2 | 4.692 | 21.325 | 97.145 |
| | PC3 | 0.628 | 2.855 | 100.000 |
| 2001-2002 | PC1 | 15.986 | 72.661 | 72.661 |
| | PC2 | 5.768 | 26.217 | 98.878 |
| | PC3 | 0.247 | 1.122 | 100.000 |
| 2002-2003 | PC1 | 16.367 | 74.395 | 74.395 |
| | PC2 | 5.133 | 23.334 | 97.729 |
| | PC3 | 0.500 | 2.271 | 100.000 |
| 2003-2004 | PC1 | 16.501 | 75.007 | 75.007 |
| | PC2 | 5.269 | 23.948 | 98.955 |
| | PC3 | 0.230 | 1.045 | 100.000 |
| 2004-2005 | PC1 | 16.628 | 75.583 | 75.583 |
| | PC2 | 5.155 | 23.432 | 99.015 |
| | PC3 | 0.217 | 0.985 | 100.000 |
| 2005-2006 | PC1 | 15.806 | 71.845 | 71.845 |
| | PC2 | 6.040 | 27.453 | 99.297 |
| | PC3 | 0.155 | 0.703 | 100.000 |
| 2006-2007 | PC1 | 16.329 | 74.223 | 74.223 |
| | PC2 | 5.551 | 25.231 | 99.454 |
| | PC3 | 0.120 | 0.546 | 100.000 |

For sales, the value of total sales and one of its sub-set (value of milk sold to local area) are the dominating principal variables out of three.

Likewise the value of depreciation on fixed capital is also a dominating principal variable. For profit, it is not gross profit, but the net profit is only dominating factor.

Dividend and bonus, which leads to a positive return on investment by the members, are also dominating principal variables of PMPCSs. These results, however, suggest that those dominating financial variables have long term positive impact on PMPCSs, which might lead to sustainability of PMPCSs in the area we surveyed.

Among four physical indicators, two (total milk procurement per day, in liter, and the number of AI cases) are the most dominating principal variables. The most dominating principal physical performance variables have also long term positive impact on PMPCSs because the expansion of milk procurement and the replacement of existing indigenous cattle by cross-breed cattle as physical dominating indicators might lead to sustainability of PMPCSs. However the study of both financial and physical performance indicators suggests that out of twenty two performance indicators, twelve performance indicators are most dominating ones of which ten are financial performance indicators and those dominating financial indicators have long term positive impact on PMPCSs. It seems to imply that financial performance indicators dominate over physical ones, and all the dominating variables have long term positive impact on PMPCSs, that supporting hypothesis ii.

**Table 3** Principal variables and their loading values of first 3 PCs for the years 1997-1998 to 2006-2007[1,2]

| Years | Principal variables of first 3 PCs | | |
|---|---|---|---|
| | Principle variables of $PC_1$ | Principle variables of $PC_2$ | Principle variables of $PC_3$ |
| 1997-1998 | $14^{th}$ (0.998), $17^{th}$ (0.997), $12^{th}$ (0.977), $9^{th}$ (0.976), {0.00} {0.001} {0.021} {0.022} $2^{nd}$ (0.973), $22^{nd}$ (0.973), $7^{th}$ (0.963), $6^{th}$ (0.954) {0.025} {0.025} {0.035} {0.044} | $11^{th}$ (0.875) {0.00} | $19^{th}$ (0.920) {0.00} |
| 1998-1999 | $17^{th}$ (0.994), $9^{th}$ (0.993), $14^{th}$ (0.990), $6^{th}$ (0.989), {0.00} {(0.001} {0.004} {0.005} $2^{nd}$ (0.976), $7^{th}$ (0.967), $12^{th}$ (0.945) {0.018} {0.027} {0.049} | $11^{th}$ (0.851) {0.00} | $5^{th}$ (0.393) {0.00} $19^{th}$ (0.390) {0.007} |
| 1999-2000 | $17^{th}$ (0.998), $9^{th}$ (0.997), $14^{th}$ (0.997), $6^{th}$ (0.987), {0.00} {0.001} {0.001} {0.011} $12^{th}$ (0.98), $22^{nd}$ (0.977), $2^{nd}$ (0.974), $21^{st}$ (0.973) {0.018} {0.021} {0.024} {0.026} | $11^{th}$ (0.780) {0.00} | $19^{th}$ (0.967) {0.00} |
| 2000-2001 | $9^{th}$ (0.997), $22^{nd}$ (0.996), $21^{st}$ (0.994), $17^{th}$ (0.990), {0.00} {0.003} {0.007} {0.016} $14^{th}$ (0.982), $2^{nd}$ (0.959), $1^{st}$ (0.954), $12^{th}$ (0.952) {0.015} {0.038} {0.043} {0.045} | $11^{th}$ (0.845) {0.00} | $19^{th}$ (0.615) {0.00} |
| 2001-2002 | $6^{th}$ (1.00), $14^{th}$ (0.998), $17^{th}$ (0.998), $2^{nd}$ (0.989), {0.00} {0.002} {0.002} {0.011} $22^{nd}$ (0.988), $12^{th}$ (0.985) {0.012} {0.015} | $16^{th}$ (0.948) {0.00} | $17^{th}$ (0.291) {0.00} |
| 2002-2003 | $14^{th}$ (0.997), $17^{th}$ (0.996), $22^{nd}$ (0.985), $6^{th}$ (0.980), {0.00} {0.001} {0.012} {0.017} $2^{nd}$ (0.978), $12^{th}$ (0.975) {0.019} {0.022} | $11^{th}$ (0.927) {0.00} | $19^{th}$ (0.514) {0.00} |
| 2003-2004 | $17^{th}$ (0.995), $14^{th}$ (0.994), $6^{th}$ (0.991), $19^{th}$ (0.980), {0.00} {0.001} {0.004} {0.015} $2^{nd}$ (0.977), $12^{th}$ (0.973), $18^{th}$ (0.959), $4^{th}$ (0.948) {0.018} {0.023} {0.031} {0.045} | $11^{th}$ (0.899) {0.00} $16^{th}$ (0.872) {0.03} | $19^{th}$ (0.175) {0.00} |
| 2004-2005 | $17^{th}$ (0.999), $14^{th}$ (0.998), $6^{th}$ (0.995), $2^{nd}$ (0.979), {0.00} {0.001} {0.004} {0.020} $21^{st}$ (0.977), $19^{th}$ (0.976), $12^{th}$ (0.972), $4^{th}$ (0.959), {0.022} {0.023} {0.027} {0.040} $18^{th}$ (0.958) {0.041} | $16^{th}$ (0.882) {0.00} | $21^{st}$ (0.190)) {0.00} |
| 2005-2006 | $17^{th}$ (1.00), $5^{th}$ (0.997), $14^{th}$ (0.993), $6^{th}$ (0.992), {0.00} {0.003} {0.007} {0.008} $2^{nd}$ (0.968), $22^{nd}$ (0.967), $21^{st}$ (0.964), $12^{th}$ (0.962) {0.032} {0.033} {0.036} {0.038} | $11^{th}$ (0.980) {0.00} | $4^{th}$ (0.231) {0.00} |
| 2006-2007 | $17^{th}$ (0.999), $11^{th}$ (0.998), $14^{th}$ (0.998), $6^{th}$ (0.986), {0.00} {0.001} {0.001} {0.013} $2^{nd}$ (0.966), $22^{nd}$ (0.966), $12^{th}$ (0.960) {0.033} {0.033} {0.039} | $16^{th}$ (0.851) {0.00} $8^{th}$ (0.835) {0.019} | $16^{th}$ (0.134) {0.00} |

[1] Note: figure in the first brackets indicates loading values of the principal variables.
[2] Figure in the second brackets indicates the degree of closeness of first loading values.

**Performance of PMPCSs**

**Index analysis**

We now examine the year-wise composite index of both financial and physical performance indicators calculated following Iyengar and Sudarshan (1982) among PMPCSs based on multivariate data (Table 4).

It shows that out of 4 PMPCSs, RPMPCS has the highest performance of all for almost all the years in the time-series analysis (for a period of 10 years), the performance of KPMPCS, SPMPCS and FPMPCS being at the descending order. Although PMPCS ranks the second highest performance, the values of indices for KPMPCS during all the years are about 70 percent or above, which are not markedly different from those retained by RPMPCS, which obtains the highest performance. But for the rest two PMPCSs-SPMPCS and FPMPCS, the values of indices are very poor for all the years (in no year the values of indices crosses above 21.32 out of 100). It might suggest that the socio-economic performance of SPMPCS and FPMPCS is very poor compared with RPMPCS and KPMPCS during the period of study (10 years) when they are judged by the combined effect of both physical and financial performance indicators.

**Profit efficiency**

This paper calculates DEA profit efficiency based on financial performance indicators only (Table 5). It shows that MPCS has the maximum efficiency score for a period of 10 years, the performance of efficiency scores for PMPCS, PMPCS and FPMPCS being at the descending order. But, significantly (P<0.05), the score of efficiency for all the MPCSs lies between 90 percent and 100 percent level. What it implies is that the difference of the values of efficiency obtained by all PMPCSs is not far from unity from one another. It might suggest that when the performance of PMPCSs is judged only on the basis of financial performance indicators, all PMPCSs perform well. So, it might be an indication that there is little need for improvement in functioning among all PMPCSs in relative perspectives when they are judged by relative efficiency level. This is also in conformity with the findings of profit efficiency which is calculated on the basis of window analysis (Partial results in Tables 6a, 6b, 6c, 6d, 6e and 6f suggesting that the significant impact of financial performance variables contributes to high profit efficiency for all primary dairy co-operative societies under study, supporting hypothesis ii. Conversely, a comparative picture that appears from Tables 4, 5 and 6 shows that when the performance of all PMPCSs under our study is evaluated on the basis of both physical and financial performance variables, two PMPCSs-SPMPCS and FPMPCS, run very badly compared with the rest two (Table 4).

It might imply that there is a significant discrepancy among all PMPCSs under our study because of the fact that the impact of physical performance variables differs significantly (P<0.05) among them. Hence there is a greater scope of improvement particularly for two PMPCSs-SPMPCS and FPMPCS, if physical performance indicators are employed more effectively. But, more importantly, when all PMPCSs are evaluated only on the basis of financial performance indicators all run well

**Table 4** Year wise composite indices of performance of the PMPCSs during 1997-1998 to 2006-2007

| Year | PMPCSs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | RPMPCS | | FPMPCS | | KPMPCS | | SPMPCS | |
| | Index | Rank | Index | Rank | Index | Rank | Index | Rank |
| 1997-1998 | 84.67 | 1 | 6.54 | 4 | 72.88 | 2 | 14.23 | 3 |
| 1998-1999 | 76.78 | 2 | 11.64 | 4 | 80.34 | 1 | 17.88 | 3 |
| 1999-2000 | 81.33 | 1 | 15.89 | 3 | 79.50 | 2 | 14.77 | 4 |
| 2000-2001 | 86.88 | 1 | 09.67 | 4 | 76.68 | 2 | 16.86 | 3 |
| 2001-2002 | 84.21 | 1 | 07.34 | 4 | 78.43 | 2 | 19.67 | 3 |
| 2002-2003 | 81.43 | 1 | 08.55 | 4 | 73.65 | 2 | 21.32 | 3 |
| 2003-2004 | 75.49 | 2 | 11.64 | 4 | 82.76 | 1 | 16.12 | 3 |
| 2004-2005 | 85.23 | 1 | 08.78 | 4 | 69.35 | 2 | 14.82 | 3 |
| 2005-2006 | 77.68 | 1 | 05.89 | 4 | 76.68 | 2 | 11.56 | 3 |
| 2006-2007 | 83.76 | 1 | 14.55 | 3 | 76.87 | 2 | 09.66 | 4 |

**Table 5** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 1997-1998 to 2006-2007

| Name of the societies | Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1997-1998 | 1998-1999 | 1999-2000 | 2000-2001 | 2001-2002 | 2002-2003 | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 |
| RPMPCS | 0.918 | 0.950 | 0.949 | 0.956 | 0.970 | 0.998 | 0.994 | 1.00 | 1.00 | 1.00 |
| FPMPCS | 0.981 | 0.912 | 0.942 | 0.901 | 0.923 | 0.976 | 0.916 | 0.884 | 0.882 | 0.874 |
| KPMPCS | 0.936 | 1.00 | 1.00 | 1.00 | 0.991 | 1.00 | 0.973 | 0.947 | 0.984 | 1.00 |
| SPMPCS | 1.0 | 0.981 | 0.963 | 1.00 | 0.987 | 0.908 | 0.977 | 0.985 | 0.944 | 0.934 |

**Table 6a** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 1997-1998 to 2001-2002

| Name of the societies | Years | | | | |
|---|---|---|---|---|---|
| | 1997-1998 | 1998-1999 | 1999-2000 | 2000-2001 | 2001-2002 |
| RPMPCS | 0.918 | 0.950 | 0.960 | 0.972 | 1.00 |
| FPMPCS | 0.990 | 0.928 | 0.944 | 0.918 | 0.939 |
| KPMPCS | 0.937 | 1.00 | 1.00 | 1.00 | 1.00 |
| SPMPCS | 1.00 | 1.00 | 0.962 | 1.00 | 0.994 |

**Table 6b** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 1998-1999 to 2002-2003

| Name of the societies | Years | | | | |
|---|---|---|---|---|---|
| | 1998-1999 | 1999-2000 | 2000-2001 | 2001-2002 | 2002-2003 |
| RPMPCS | 0.950 | 0.950 | 0.958 | 0.973 | 1.00 |
| FPMPCS | 0.928 | 1.00 | 0.918 | 0.947 | 0.985 |
| KPMPCS | 1.00 | 1.00 | 1.00 | 0.997 | 1.00 |
| SPMPCS | 1.00 | 0.926 | 1.00 | 0.994 | 0.923 |

**Table 6c** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 1999-2000 to 2003-2004

| Name of the societies | Years | | | | |
|---|---|---|---|---|---|
| | 1999-2000 | 2000-2001 | 2001-2002 | 2002-2003 | 2003-2004 |
| RPMPCS | 0.950 | 0.959 | 0.973 | 1.00 | 1.00 |
| FPMPCS | 1.00 | 0.914 | 0.941 | 0.986 | 0.917 |
| KPMPCS | 1.00 | 1.00 | 0.997 | 1.00 | 0.975 |
| SPMPCS | 0.962 | 1.00 | 0.993 | 0.923 | 1.00 |

**Table 6d** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 2000-2001 to 2004-2005

| Name of the societies | Years | | | | |
|---|---|---|---|---|---|
| | 2000-2001 | 2001-2002 | 2002-2003 | 2003-2004 | 2004-2005 |
| RPMPCS | 0.958 | 0.973 | 1.00 | 0.996 | 1.00 |
| FPMPCS | 0.901 | 0.980 | 1.00 | 0.916 | 0.884 |
| KPMPCS | 1.00 | 1.00 | 1.00 | 0.975 | 0.952 |
| SPMPCS | 1.00 | 0.987 | 0.908 | 1.00 | 0.904 |

**Table 6e** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 2001-2002 to 2005-2006

| Name of the societies | Years | | | | |
|---|---|---|---|---|---|
| | 2001-2002 | 2002-2003 | 2003-2004 | 2004-2005 | 2005-2006 |
| RPMPCS | 0.980 | 1.00 | 0.996 | 1.00 | 1.00 |
| FPMPCS | 0.947 | 1.00 | 0.939 | 0.905 | 0.903 |
| KPMPCS | 1.00 | 1.00 | 1.00 | 0.956 | 1.00 |
| SPMPCS | 1.00 | 0.914 | 1.00 | 0.918 | 0.945 |

**Table 6f** DEA efficiencies of four primary milk producers' co-operative societies (PMPCS) for years 2002-2003 to 2006-2007

| Name of the Societies | Years | | | | |
|---|---|---|---|---|---|
| | 2002-2003 | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 |
| RPMPCS | 1.00 | 0.997 | 1.00 | 1.00 | 1.00 |
| FPMPCS | 1.00 | 0.939 | 0.905 | 0.903 | 0.894 |
| KPMPCS | 1.00 | 1.00 | 0.964 | 0.990 | 1.00 |
| SPMPCS | 0.914 | 1.00 | 0.893 | 0.945 | 0.937 |

(Table 5/Table 6) which implies that there is little need for improvement in functioning among all PMPCSs when their performance are evaluated only on the basis of financial performance indicators.

## CONCLUSION

The important finding that emerges out of this study indicates that there exist two main underlying dimensions in the

performance of the primary co-operatives: namely physical indicators, financial indicators and financial performance indicators dominate over physical performance indicators. Among financial indicators, value of total purchase including milk products (14th PI), value of total sell (17th PI), value of milk purchase (12th PI), the value of current assets (6th PI), Govt. grant in aid (11th PI), the dividends and bonus paid (22nd PI), total depreciation (19th PI), net profit (21st PI), share capital (9th PI), total milk sell (16th PI), the value of fixed assets (5th PI), the value of total assets (7th PI) and total expenditure (18th PI) and current liabilities (8th PI) are the principal variables. Total milk procurement per day (2nd PI), the number of AI cases (4th PI) and total number of membership (1st PI) are the principal variables among physical performance indicators. These might imply that the most dominating financial and physical variables have long term positive impact on the sustainability of PMPCSs. The study also shows that among PMPCSs, two PMPCSs-RPMPCS and KPMPCS obtain higher ranks of the composite index, which is estimated on both financial and physical performance indicator, for all the years; but for the rest two PMPCSs-SPMPCS and FPMPCS, the values of indices are very poor during the same period. Hence there is a greater scope of improvement in the functioning of two PMPCSs-SPMPCS and FPMPCS in particular, if physical performance indicators are employed more effectively.

The study also lends credence to the fact that, when the profit efficiency is measured only on the basis of financial performance indicators the score of efficiency for all the PMPCSs lies between 90 percent and 100 percent level. It suggests that when the performance of PMPCSs is judged only on the basis of financial performance indicators, all PMPCSs perform well. But there is a greater scope of improvement among all PMPCSs if physical performance indicators are employed more effectively. Therefore, to increase the efficiency and productivity of dairying of all the members in general and small farmers and landless labour members in particular, the PMPCSs should focus their attention on: a) replacing more the indigenous cows by cross-bred cows, b) increase their membership and converting them into professional entrepreneurs so that milk procurement per day (measured in kilogram) can be increased significantly and c) acting as viable agents between financial institutions and dairy members so that the average sale of cattle feed (measured in kilogram) per member can be increased in order to expand milk procurement per day both qualitatively and quantitatively. This might be of great help to the policy maker, office bearers of the dairy co-operatives and researchers in judging the real performance of primary dairy co-operatives operating in West Bengal. It would also ensure socioeconomic upliftment of the small farmers and landless laborers, who are the members of PMPCSs.

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