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India's Milk Revolution

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India's White Revolution, which has quietly swept the country during the past few decades, deserves attention equal to that given to the better-known Green Revolution. The White Revolution holds the promise of raising the nutritional status of underprivileged sections of our people. With a production forecast of 74 million tonnes in 1998-99, India has become the largest milk producer in the world¹. From being a major importer of dairy products in the 1950s, India has now become an exporter. Milk has become India's most important farm commodity, the value of its output (in 1994-95) of Rs 500,000 million exceeding that of paddy². These achievements have been realised against great odds: a national herd of poor yielders, crop residues and agricultural by-products as the main feed, and a lack of adequate marketing support and finance. The true heroes of our rural transformation are not the grain or oil seed farmers, they are the women and men who have raised the productivity of our nation's cattle and buffaloes³.

PRESENT SCENARIO

The success achieved in the augmentation of milk production in the country is reflected by the fact that milk production has risen from a mere 16 million tonnes in 1950 to 74.3 million tonnes in 1999. As against a per capita availability of 132 g per day in 1950, the present per capita availability is almost 214 g per day, despite tremendous increase in population in

the last 50 years. This milk was produced by 70 million dairy farmers from a milch herd comprising 57 million cows (31 million in milk) and 39 million buffaloes (25 million in milk) with an average milk yield of 1,250 kg. Almost the entire quantity (98 per cent) was produced in the rural sector. Only 10 per cent of the milk produced (20 million litres per day) was processed in dairy plants. The value of the output of the dairy plants was Rs 1,050,000 million. On the consumption side, 44 per cent of the total production was consumed in the rural sector either as liquid milk or after local conversion into products; the remaining 56 per cent was consumed in the urban sector. The pattern of consumption in the country is shown in Table 1.

By far the major part (84.3 per cent) of the liquid milk consumed in urban areas is supplied by the traditional or unorganised sector of *dudhiyas* and milk shops. In the organised sector, while cooperative dairies sell 90 per cent of the milk they process as liquid milk, the private sector converts 80 per cent of its throughput into products. The organised sector processes milk in 370 milk plants and product factories and is growing at an average annual rate of 10 to 15 per cent. In the last 25 years, its throughput has increased by six times. The average installed capacity of dairy plants has also increased: from 10,000 to 20,000 litres per day in the 1950s, it climbed to 100,000 litres per day in the 1970s, to 500,000 litres per day

and finally to 1 million litres per day (mlpd) in the 1980s and 1990s. India's first automated dairy plant of 1 million litres per day capacity, the Mother Dairy at Gandhinagar in Gujarat, was commissioned in 1996. Amul-III, which with its satellite dairies has a total installed capacity of 1.5 mlpd, was commissioned in 1997⁴.

Of the liquid milk consumed in India, a substantial part is used for whitening coffee or tea⁵. For the economically weaker sections, this use accounts for almost all milk consumed. The fat content of milk is not of much consequence for this usage, hence the sizeable demand for lower cost toned and double-toned milks. The volumes of different types of milk marketed by the cooperative sector is shown in Table 2.

India has made praiseworthy innovations in liquid milk distribution systems. Sachets and bulk vending have replaced bottles, lowering and eliminating packing costs. Currently, sachets account for 82 per cent and bulk vending for 14 per cent of the milk sold.

As seen from Table 1, 95 per cent of the organised sector products are accounted for by liquid milk, *ghee*, butter, *dahi*, *khoa* and *paneer*, all be-

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TABLE 1
Consumption and Value of Milk and Milk Products, 1997-98

Products	Quantity ('000 mt*)	Milk equivalent ('000 mt)	Percentage
Liquid milk	32,447	32,447	45.7
Buttermilk/separated milk	24,140	24,140	34.0
Ghee**	986	0	0
Makkhan (butter)	33	0	0
Dahi (curd)	4,899	4,899	6.9
Khoa and condensed milk	980	4,615	6.5
Milk powder, including infant food	243	2,627	3.7
Paneer, chhana and cheese	228	1,349	1.9
Ice cream and kulfi	54	426	0.6
Cream	18	142	0.2
Others (milk equivalent)		355	0.5
Total		71,000	100.0

*mt: metric tonnes

**Ghee (27.5 per cent) and makkhan (6.5 per cent) are derived during the production of buttermilk/separated milk. Some quantity of ghee is also obtained during the manufacture of skimmed milk power (SMP).

Source: Milk production in 1997-98. Annual Report, Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India. Pattern of Consumption: Dairy, India 1997.

ing traditional. The remaining 5 per cent of the 'western' type of products such as table butter, cheese, baby food and milk powders are gaining importance, especially among urban consumers. These products also have export potential.

AMUL AND THE ANAND PATTERN

India's White Revolution had its origin in a single small enterprise started in Gujarat State. In 1946, at the suggestion of Sardar Vallabhbhai Patel, the farmers in Kaira district formed a cooperative union to supply milk directly to the Bombay Milk Scheme (BMS), cutting out private dairy and middlemen who were then supplying to BMS. The Karia Union began with two societies and a daily milk collection of not more than 200 litres of milk, under the chairmanship of Shri Tribhuvandas Patel⁶. Right from the inception of the dairy cooperative itself, a vital link was established between the producer and Bombay's market, ensuring the incentive of a stable and remunerative price to the farmer. The bulk of the milk is produced during the winter flush season while demand remains relatively con-

stant throughout the year, peaking in the summer when production is lowest. The trade exploited this situation by paying the producer 50 per cent of the summer prices during winters thus taking away the incentive to produce more milk. By installing drying equipment, the cooperative was able to conserve surplus flush season milk, marketing it during the lean season. In winter, the cooperative paid the farmers 80 per cent of the lean season price, which meant they earned 50 per cent more for their year's production⁷. As the demand grew, the cooperative installed processing facilities to match it. The basic principle of matching the rising demand by enhancing supplies has characterised pre- and post-Operation Flood developments. In fact, the shift in the supply function from the policy changes introduced with OF resulted in an even larger shift in the supply function and stable real consumer prices⁸.

The structure of the Anand pattern was established from the beginning. Initially it included two tiers, the primary village Dairy Cooperative Societies (DCS) of milk producers at the base, with a cluster of such soci-

eties forming a District Milk Producers' Union entrusted with procurement and processing. As Kaira District was joined by other unions in Gujarat, an apex Federation of Unions was created to market their milk and milk products. The organisations at each level are governed by their own by-laws and are managed by democratically elected boards. The facilities at all levels are entirely farmer owned⁹. By appointing qualified technologists and professional managers, the cooperatives also made sure that the farmers' productive genius was linked to modern management and technology⁶. I consider myself fortunate to have had the opportunity of being associated with this cooperative enterprise almost at the beginning and working with Shri Tribhuvandas Patel and to lead the team of highly-skilled and dedicated professionals that we were able to assemble.

From the modest beginning in 1946, Kaira District Cooperative Milk Producers' Union, or Amul as it became popularly known, has made exceptional progress. Virtually every village has a cooperative to which members bring their milk every morning and evening. The quantity of milk is measured (or lately, weighed) and a sample is drawn from each farmer to test the fat content of his supply. In tune with its policy of bringing the latest technological advance to the doorstep of the farmer, each society is provided with an electronic fat tester. Based on the quantity and fat content the amount to be paid is calculated. Payment for morning milk is made in the evening; that for evening milk is made the following morning. With the introduction of computers, many societies weigh and measure fat simultaneously and milk is paid for immediately on receipt. The Union has

TABLE 2
Daily Milk Marketing in Urban Areas

Type of milk	Quantity ('000 litres/d)
Double toned (1.5)	448
Toned (3.0)	2,911
Standardised (4.5)	1,791
Full cream (6.0)	504
Total	5,654

Figure in parenthesis indicate the fat content.

Source: NDTB

always ensured that productivity enhancement measures are available to its members. Modern plants produce high protein concentrate feeds and make them available at the cooperatives. The Union provides animal health care and breeding facilities. Artificial insemination service with good quality semen was introduced through trained village society workers. A mobile veterinary service was provided for veterinary first aid. Above all, the best incentive for enhanced production was the Union's undertaking to buy the entire quantity offered by the farmer irrespective of the season. By the year 1965-66, Amul had 518 DCs with 110,000 members. It collected 65,905 tonnes of milk and could process 500,000 litres of milk a day. It sold products of a total value of Rs 92.2 million². These products ranged from milk to baby food, whole milk and skimmed milk powders, condensed milk and cheese.

OPERATION FLOOD

In contrast to Amul's remarkable progress, the government tried various animal husbandry and dairy development schemes during the period 1951-70 at a total cost of Rs 11,400 million, but none of them yielded the desired results; many were dismal failures¹⁰. It was at this juncture that the then Prime Minister of India, late Shri Lal Bahadur Shastri, paid a visit to Kaira district on October 30-31, 1964. He came at Kaira Union's invitation to inaugurate a modern cattle feed plant, then – as now – the largest in the country. Spending a night in a village in the company of farmers and unaccompanied by officials, the Prime Minister saw and heard first hand from the farmers the transformation brought about by the Anand pattern of milk cooperatives. On his return to Delhi, he set in motion the effort to create Anands in all parts of India. The National Dairy Development Board (NDDB) was formed in 1965 and was charged with the responsibility of building cooperative dairies in India on the Anand pattern.

In the beginning, the NDDB faced many obstacles. The Dairy Board had few financial resources; state governments and departments had little interest in turning over their responsibilities to farmers and, even more, in becoming employees of farmers. In Gujarat, farmer initiatives, supported by the Kaira Union, resulted in significant progress; elsewhere little change

occurred. It was about this time that mountains of powder and lakes of butter oil were accumulating in Europe. It was, we feared, just a matter of time until some kindly European gentleman decided that this should be donated, or sold at subsidised prices, to help the 'poor people of India'. Were that to happen, it would have been the death knell of our nascent dairy industry. It was to face this potential threat that the idea arose of using food aid to generate the financial resources necessary to create Anands throughout India. Fortunately there were individuals of wisdom and foresight in both India and Europe who supported the idea. So, donated commodities were reconstituted as liquid milk and sold at prices comparable to those in the domestic market. The funds that were generated were used to finance the development of our cooperative dairy industry. Thus, what was a serious threat was successfully turned into an asset⁶.

Operation Flood, the programme to replicate Anand and create a flood of milk in India's villages, was launched in 1970. The Amul experience had established, tested and proved the guiding principles for dairy development: a three-tier cooperative structure owned and controlled by farmers, professionally managed, providing the inputs for production enhancement, purchasing all the farmers' milk, processing and marketing it in urban markets. As the World Bank recently acknowledged, there was thus already a model in place to implement dairy development and the programme involved institution building as distinct from institution creation⁸.

The targets for the first phase of Operation Flood included:

- organising village-level dairy cooperatives with the required physical and institutional infrastructure to support production and procure milk
- creation of union-owned and managed modern production enhancement, processing and marketing facilities
- establishment of metro dairies. The thrust was to link Bombay, Calcutta, Delhi and Madras with the country's 18 best milksheds, capturing commanding shares of these urban milkmarkets.

Operation Flood's second phase, implemented during 1981-85, targeted a rapid expansion to 136 milksheds

linked to over 290 urban markets with a total population of over 15 million. The numbers of societies, members and volumes of milk procured, all more than doubled. The third phase, implemented during 1985 to 1996, involved strengthening the basic infrastructure and measures for production enhancement and animal healthcare and nutrition and thus consolidating the gains of the first two phases.

In the 25 years since the launch of Operation Flood, national milk production has more than trebled and per capita availability almost doubled. A robust infrastructure with rural processing capacity of 19.4 mlpd and 6.7 mlpd equivalent of chilling capacity to ensure good quality of milk has been set up. For the urban consumers, milk marketing facilities of 7.2 mlpd are in operation. The entire Operation Flood programme was financed by funds generated from the gifts of butter oil and SMP from the World Food Programme and the European Economic Community, supplemented in the last phase by World Bank loans. The internal resources employed increased from phase to phase. Future dairy development will be self-financing without dependence on external aid or loan¹¹. Today, OF is a huge undertaking involving (in 1998-99) 10.1 million farm members supplying an average of 13,659 metric tonnes of milk per day through more than 81,000 cooperative societies to 170 milk producer unions who process and market it as liquid milk and processed products. In 1997-98, the system included 13,377 Artificial Insemination Centres and 787 mobile veterinary clinics.

SUPPORT ROLE OF NDDB

As the prime mover of the OF programme, in addition to financing the unions on a grant-cum-loan basis, NDDB provides extensive support for their successful performance. It coordinates its activities with those of the Technology Mission for Dairy Development and other government agencies. NDDB assists the unions in recruitment and training of personnel; technical help is provided in design and selection of equipment as well as in construction of dairy plants on a turnkey basis.

Research in products, processes and biotechnologies, both in-house

and in collaboration with other government and non-government agencies, supports the cooperative dairy industry. Product research is aimed at diversification, extension of the product range and shelf life through suitable packaging. Frozen sliced *paneer* and continental cheese are recent additions to the long-established product range of baby food, processed cheese, condensed milk, milk powders and a number of traditional milk products. Processes have been established for the mechanised and hygienic production of traditional products including *ghee*, *paneer* and *lassi*, and sweets such as *peda*, *gulab jamun*, *shrikhand*, and *mishti dohi*, as well as flavoured milk drinks¹². These products are now marketed in long-life packaging.

We have come a long way from the early days of Amul when some multinationals and exporters of milk products to India, with vested interests, declared that buffalo milk was unsuited even for powder production, let alone baby food and condensed milk. Amul met that challenge and proved them wrong¹³. It has been amply demonstrated that the Indian dairy industry is capable of making products of a standard equivalent to the best in the world². In fact, based on this performance the Codex had to amend its definition of milk from the mammary secretion of the cow alone – as was the case till recently – to that adopted in the Indian Prevention of Food Adulteration (PFA) Rules, namely, the mammary secretion of milking animals¹⁴. International Dairy Federation has approved cow and buffalo milk as raw material for a variety of cheeses.

Research in biotechnology has yielded valuable results, in all the three areas of production enhancement,

namely, feeding, animal health and breeding. Simple and inexpensive innovations such as bypass protein feed, urea molasses blocks and the urea treatment of straw, all improve the nutritional quality of the animals' normal feed. Through the Foot-and-Mouth control project 42.1 million vaccinations have been carried out.

Indian Immunologicals, a subsidiary of NDDB, produces a variety of vaccines including rabies and theileriasis as well as a number of veterinary formulations². Upgrading of *Surti* and *Murrah* buffaloes as well as crossbreeding of *Bos zebu* with *Bos taurus* is being undertaken in a number of research institutions. DNA finger printing is used to select bulls with desirable breeding traits. Field-based techniques such as embryo transfer are adopted for the rapid multiplication of breeding stocks. Farmers are progressively investing in crossbred cows because of their high yields. Increase in the supply of cow milk is having the salutary effect of an even intake of milk by the dairies throughout the year¹⁵.

Milk production in India is subject to not only seasonal variations but also to regional disparities as can be seen from Table 3. The National Milk Grid (NMG) is designed to move milk from surplus to deficit areas. Adequate storage facilities for frozen butter and milk powder have been set up at strategic locations. India's achievement in dairy development has attracted the attention of other developing nations who are dependent on imports and are keen on indigenous dairy development. Sri Lanka has set up Kiriya Milk Industries of Sri Lanka in collaboration with NDDB. The Dairy Board has set up a dairy in the former Soviet republic of Kyrgyzstan¹⁶.

LOOKING AHEAD

India enjoys a competitive advantage due to the low farm gate price of milk. In much of India, milk production is symbiotically integrated into agriculture. The farming system provides low cost residues as feed and fodder for animals. Milk production, in turn, supports draught power and organic fertilisers. For two-thirds of the 280 million rural Indians engaged in agriculture, the farming system generates employment for only a minor part of the year. Dairying sets right the imbalance in employment. It assures a regular income to landless as well as small and marginal farmers. The buffalo is an efficient converter of low-grade fibrous feed into high value milk⁴. Economic liberalisation and the dairy industry's rapid growth has attracted Indian business and multinationals. Their entry carries the risk that big business will transform the dairy industry production by the masses to mass production².

Operation Flood has been one of the largest and most successful rural employment schemes in the world. Cooperative dairying means regular income to lakhs and lakhs of small farmers. Cooperative dairying has not been merely the modernisation of milk production but has larger technological, economic and social dimensions. It has created and nurtured democratic structures at grass root levels⁶. Such gains should not be endangered. Above all, the future of India's dairy farmer is a trust that each of us holds. We cannot and must not let them down². The dairy industry's future depends on expanding and meeting the domestic demand and carefully building a sustainable export for Indian milk and milk products. The tendency to exploit our competitive advantage by unbridled emphasis on exports should be curbed.

Since it is apparent that the government is not inclined to play a role in regulating the industry, we should evolve voluntary self-regulatory mechanisms to govern our performance, thereby attaining and maintaining the highest standards of quality of products². India will have a surplus of milk from time to time, but it is a surplus only to the extent that a substantial section of our population cannot afford adequate milk and milk products. The benefits of increased milk production has given the middle class

TABLE 3
Regionwise Distribution of Milk Production, Human Population and Per Capita Availability, 1995

Region	Population (million)	Milk production (mmt)	Per capita Availability (g/day)
Northern	261.9	29.4	308
Western + Central	202.8	14.0	189
Southern	212.8	13.5	174
Eastern	235.9	9.4	109
Total National	913.4	66.3	199

Source: Dairy India, 1997.

a range of products at reasonable prices. Access to these has not yet trickled down to the urban and rural poor. These are the sections of our population who need milk the most and whose consumption of milk is virtually nil. There should be no curb on increased milk production. At the international level, nations that can produce a surplus should aid those who are yet unable to fully feed themselves. Just as it was in Operation Flood, surplus food can and should be used as an investment to increase the production and productivity of those in need at present. India should be prepared to commit her experience, human resources and, to the extent she can, her commodities, to achieve this goal. This is the way she can salute those who helped us create the White Revolution⁶.

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COMMENTS

Dr Kurien has been the architect of India's successful Milk Revolution. His remarkable success was achieved through his efficient management, co-ordination and effective utilisation of available indigenous resources. This would incidentally underline the importance of enlightened and dedicated leadership.

Though, thanks largely to Dr Kurien's efforts, India today is the largest milk producer in the world, milk production still falls far short of national requirements for adequate nutrition. As against the present production of about 74 million tonnes, national requirement will be as high as 173 million tonnes by 2020. Milk productivity per animal in India (1,250/lactation) is still very poor compared to international levels (2,038 kg/lactation) due to gradual breed deterioration. Thus, while we have every reason to feel gratified with the success achieved so far, there is no room for complacency. We must build on the solid foundation laid by Dr Kurien.

– CG

FOUNDATION NEWS

Twenty-first Anniversary

The Foundation celebrated its 21st Anniversary on November 29, 1999. The occasion was marked by the inauguration of a 'Diet Counselling and Research Unit' (DCRU) by Dr Uton M. Rafei, the Regional Director-General of WHO (SEARO). He also released the Foundation's Five-year Report.

Foundation Day Lecture

● Dr S. Padmavati, Director, National Heart Institute, on 'Nutrition and Chronic Degenerative Diseases', on November 29.

Study Circle Lectures

● Dr D.J.P. Barker, University of Southampton, UK, on 'Foetal Origins of Cardiovascular Disease', on October 14, 1999.

● Dr N. Kochupillai, Professor and Head, Department of Endocrinology, on 'Nutritional Support in Primary Disorders of the Gastrointestinal Tract Complicated by Endocrine Manifestations', on December 22, 1999.

● Nutrition/Health Education for Children and Adolescents in Schools

The Foundation has recently launched a programme to impart need-based Nutrition and Health Education to children and adolescents in schools, in order to bring about a positive change in their diets and lifestyle practices through lecture-cum-demonstration and discussion sessions. During the last three months, more than 600 students from eight leading public schools of Delhi have participated in these sessions. In addition, half-day nutrition seminars/workshops are also being organised for school teachers.

Fund Raising

The Foundation is grateful to Dr Rajammal P. Devdas for her generous contribution to the corpus fund.

DR REG PASSMORE

The passing away of Dr Reg Passmore is a grievous loss to the world of Nutrition Science. He was the Acting Director of the Nutrition Research Laboratories at Conoor in the 1940s, and was a genuine friend of India. I had been in constant communication with him all these years. I still cherish the last letter he wrote to me on January 25, 1999. Nutrition scientists all the world over will remember him as the author of probably the most outstanding textbook on nutrition. He was an erudite scholar and a sound physiologist. Indian nutrition scientists will miss him greatly.

– CG