COOPERATIVES AND THE COMMERCIALIZATION OF MILK PRODUCTION IN INDIA

A Literature Review

by

Harold Alderman
George Mergos
Roger Slade

International Food Policy Research Institute
Washington, D.C.

August 1987

CONTENTS

TABLES

FOREWORD

Increased commercialization of semisubsistence agriculture is an important part of efforts to increase incomes and improve living standards in rural areas of many developing countries. However, effects on the incomes, food consumption, and nutritional status of the rural poor depend on how the increased commercialization is brought about; that is, the design and implementation of projects and policies and the response by the rural poor to changes in incomes, prices, labor demand, and other relevant factors.

The International Food Policy Research Institute is undertaking research to assess the effects on income and nutrition of increased commercialization of traditional agriculture in several countries and to generate new knowledge useful for those designing and implementing policies and projects, thus helping to avoid negative and to enhance positive nutrition and income effects.

Some of the results from this research will be published as IFPRI research reports. This series of working papers is intended to meet requests for additional information on commercialization of semisubsistence agriculture in various countries. These working papers complement IFPRI's research reports by providing detailed but primarily descriptive analyses.

In this working paper, Harold Alderman, George Mergos, and Roger Slade review the available literature regarding dairy development and the evolution of milk cooperatives that led to increased commercialization of the milk market in India. The paper does not purport to be an evaluation of Operation Flood or other dairy development programs of the National Dairy Development Board or the Government of India. Based on the extensive literature review, the authors identify knowledge gaps and suggest research priorities that, if followed, would establish the effects of dairy development on nutrition and incomes and allow the design of policies and programs that would mitigate risks and avoid adverse effects on producers and consumers.

Joachim von Braun
Eileen Kennedy

ACKNOWLEDGMENTS

This paper represents part of the results of a collaborative research project undertaken by the World Bank and the International Food Policy Research Institute. Partial funding was provided by a grant from the Danish International Development Agency (DANIDA). We would also like to thank Mogens Jul and Vasant Gandhi for their helpful comments on earlier versions and Ketki Bhagwati for assistance during the drafting of this paper.

Harold Alderman
George Mergos
Roger Slade

1. INTRODUCTION

THE RATIONALE FOR DAIRY DEVELOPMENT

Dairy development is a major component of strategies to expand agricultural output in many developing countries. In regions that are hilly or semiarid, a concentration on pastoralism may be in keeping with the ecological resource base. In other, often more favored, regions the proximity of urban markets provides a demand for dairy products and hence may encourage investment in dairying. Cattle raising is also a component of many farming systems that are not mainly livestock-oriented, since cattle utilize crop by-products and provide a store of capital and a source of draft power. The tending of cattle is labor-intensive and may be well suited to small farms with otherwise surplus labor, especially female and child labor. Hence, programs for dairy development are often presented as mechanisms for improving the welfare of poor regions, poor people, or both.[1] Crotty provides an overview of the role of cattle in the Indian agricultural sector, while John extensively reviews the dairy subsector.[2]

An important role for dairy development is suggested by the relatively high income elasticities of demand commonly observed for dairy products. Such high elasticities suggest a ready market, provided it can be reached economically, and opportunities to exploit linkages to other sectors of the economy. In the absence of increases in domestic dairy production, developing countries face increased imports or rapidly escalating prices as the demand for milk and milk products grows as fast as, or faster than, incomes. Moreover, price elasticities of demand are generally higher for dairy products than for foodgrains and are often greater than unity.[3] Therefore, total expenditure on milk will increase if price falls. Declining prices may result from economies of scale, technological innovation in milk production, or a reduction in the costs of marketing and processing.

Nutritional considerations may also stimulate dairy development. The nutritional value of milk is high and of particular value when it is included in the diets of young children. Dairy development justified on these grounds sometimes overestimates the physiological importance of milk and underestimates the economic costs of supply. It is, however, an argument that often finds favor among both planners and politicians.

Most forms of dairy development promote milk as if it were a cash crop. This entails special problems of marketing because milk is much

more perishable than most crops. The difficulties of linking numerous dispersed small milk producers to major centers of consumption is a severe logistical challenge. Like many field crops, milk production is seasonal, but unlike grains, for example, cannot be stored in its raw form. Hence product transformation is necessary in order to utilize flush season production effectively. The ease with which milk can be adulterated makes quality control necessary at both the producer and retail levels.

In some respects, dairying resembles tree crops more than subsistence field crops, since there are several years between the birth of a cow and its first lactation. The periods between successive lactations are also times of considerable cash outlay that provide no immediate payoff. Furthermore, cows--the major asset--are mortal. These production risks are somewhat different from those characterizing most other forms of capital formation. Therefore, dairy development may benefit from institutional arrangements and policies that reduce these risks.

INSTITUTIONAL STRATEGIES TO PROMOTE DAIRY DEVELOPMENT

In response to the marketing problems already mentioned, dairying is frequently promoted through collective marketing arrangements in both developed and developing countries. One of the best-known arrangements of this kind in a developing country is the Anand Milk Producers Union Ltd. (AMUL) in Gujarat, India. The success of this cooperative, which was established by private initiatives in preindependence India, has encouraged the Indian government to attempt widespread replication of the pattern in three ambitious programs: Operation Flood I (1970-81, target of one million producers), Operation Flood II (1979-85, target of 10 million producers), and Operation Flood III, scheduled to be completed in 1990. Operation Flood aims to improve milk production and supply on a national scale through the creation of thousands of village milk producers' cooperatives known as dairy cooperative societies. These cooperatives are grouped into unions and the unions into State Dairy Federations. The unions build, own, and operate milk-processing plants and collection and distribution networks. At the national level, the National Dairy Development Board (NDDB) provides technical assistance to state operations and the Indian Dairy Corporation (IDC) provides finance. This organized dairy sector, in contrast with the informal and traditional market structure, is intended to capture a dominant share of the Indian metropolitan milk market. The evolution of this strategy is described in detail below. The interest in this approach to dairy development goes beyond understanding a major Indian government undertaking, since it may yield lessons for dairy development strategies in other Asian and Latin American countries and has been considered as a model for Africa.[4]

CURRENT DEBATE AND STATE OF KNOWLEDGE

Operation Flood has a prominent place in India's development strategy and its role and strategy are widely debated. The program has, however, been favorably evaluated by the World Food Programme of the United Nations, the World Bank, and the Government of India evaluation committee chaired by L. K. Jha (the report of this committee is hereafter referred to in text as the Jha Report).[5] These reports have been widely criticized, most recently by George, for excessive praise, muted criticism, poor data, weak analysis, and contradictory conclusions.[6] Additionally, the NDDB and the IDC in India have claimed Operation Flood to be successful, but these organizations have been criticized for denying scholars access to complete records and other data.[7] Other scholars, however, have acclaimed the openness of these institutions.[8] Operation Flood has also been criticized by those who observe social ills and inappropriate priorities in the program, while others have praised its egalitarian objectives.[9] The scarcity of accessible and objective data and independent studies, a point frequently noted in the Jha Report, has produced a largely rhetorical and sometimes heated debate that is based mainly on anecdote, casual empiricism, and the constant citing and reciting of the same works.[10]

One school of thought concedes that the original Anand scheme was successful but claims that it is not replicable. They argue that the special conditions present in the Kaira district of Gujarat in 1946 are not to be found elsewhere and cannot be imposed or created. Others say that Operation Flood's planners fell victim to the fallacy of imitation and neglected issues that arise when the scale of activity is greatly expanded.[11] Similarly, they argue that resources such as capital and cattle feed necessary to achieve initial success in Gujarat were partly obtained from other regions of India. Therefore, some critics maintain that if the national program reaches the intensity of dairying in Anand, it will overstrain India's feed and grazing capacity.[12]

Other writers argue that the widespread increases in production in the 1970s attributed to Operation Flood are a myth.[13] Some suggest that the supply response induced by Operation Flood has been small--too small to allow the economic operation of the extensive milk-processing facilities that have been created. This is attributed to consumer prices being kept artificially low and, by implication, to low producer prices.[14] In this context, scale is important. Although the supply response to any given project under Operation Flood may be positive, the aggregate effects must be viewed in perspective. The Government of India has estimated that total milk production in India was about 21 million tons in 1970 and about 38 million tons in 1984, of which about 2 million tons were marketed through Operation Flood projects (all tons referred to in this paper are metric tons).[15]

Another group of critics claims that the Anand pattern and Operation Flood have concentrated more on marketing than production. These critics acknowledge that milk production has increased slightly in

recent years, but note that it is increasing at a lesser rate than the impressive growth of grain production, and that the growth has come mainly from increases in the buffalo herd rather than from breeding improvements and a reduction in animal numbers. Given the almost stagnant production of green fodder, the lack of good grazing land, and the expense of animal feeds, the critics claim that such expansion, at the extensive margin, is not sustainable.[16]

Moreover, it is argued, programs that fail to expand production merely shift consumption, through the marketing chain, from rural to urban consumers to the detriment of the former. In its most naive version, this argument overlooks the fact that such sales are voluntary and provide income that can be used for other household purchases, including other foods that may be cheaper sources of nutrients. More realistic versions of this argument point to the increase in the price of buttermilk and fluid milk that could follow from improved marketing and to the harmful effects that such price rises might have on rural consumers of dairy products.[17]

Ironically, although such arguments imply that the cooperatives lead to higher rural prices, at least for some products, some critics contend that the approach is oriented toward reducing marketing margins without passing the savings on to the rural producer. These savings, it is alleged, are divided between urban consumers and the increased capitalization of the cooperative.[18]

These concerns lead to further criticisms. Some commentators contend that whatever gains are achieved under Operation Flood, few will accrue to the poor. George, citing evidence in Patel and Pandey, emphasizes that harijans are sometimes discouraged for reasons of caste from joining or even selling milk to the dairy cooperatives.[19] By enhancing returns to the relatively rich, Operation Flood will increase their share of the investment in cattle. Therefore, because the rich can better bear risk and tolerate poorly developed markets for feeds, milk production opportunities for the poor will eventually be greatly reduced.[20]

Some critics are concerned not only with the price of milk but with the effects of dairy development on the prices of foodgrains, such as sorghum and millet. Demand for these grains to be used as animal feeds will, they argue, bid up prices and thus lead to a decline in the real incomes of the poor. Some suggest that even if the poor do not lose absolutely because of Operation Flood, there may be a relative loss as the distribution of income becomes more skewed.[21] This, however, is as much a question of political philosophy as it is an empirical issue. Nevertheless, the Indian dairy cooperative movement, which was conceived as a mechanism for improving marketing efficiency and increasing production, has come to accept among its objectives the improvement of the welfare of the poor and other egalitarian goals.[22] If only for this reason, the distribution question is now a central issue in the evaluation of Operation Flood.[23]

In sharp contrast to the critics, one of the major views held by proponents of the dairy cooperative movement is that increased milk production has resulted in increased incomes for the poor.[24] This, they suggest, has resulted from an increase in the demand for labor, which has given employment to previously unemployed or underemployed members of rural households; for example, women and children. This, they claim, is of greater relative importance for landless households than for landed families.

Advocates of Operation Flood contend that the increased milk production under the program has a significant positive impact on rural consumption patterns.[25] The income generated from dairying, they claim, can be used to buy cheaper commodities with nutritional value the same as or higher than milk, which is a relatively costly commodity. These writers argue that higher productivity and incomes in cooperative villages allow producers to purchase greater quantities of food and they seek to dispel the notion that cooperatives adversely affect rural nutrition by draining milk away from rural to urban areas.[26] Others also claim that living standards have risen as a result of Operation Flood.[27]

Supporters argue that by making milk available cheaply to urban consumers, Operation Flood has made milk consumption feasible for those who do not belong to the highest-income groups. They contend that the cooperative sector's substantial share of urban milk markets has stabilized the price of milk compared with the prices of other food items. Some also claim that the price of milk has fallen relative to the price of most food items, so milk is more accessible to lower-income groups.[28]

This argument is related to the issue of milk availability in rural areas. According to proponents of Operation Flood, milk production has increased significantly since the inception of the program. They claim that with the resulting increase in milk availability, the average quantity of milk consumed per household, especially among the poor, has increased.[29]

According to supporters, the participation of lower castes in the dairy cooperative movement is also an important achievement. By allowing both high and low castes equal access to the village dairy cooperative society, Operation Flood has promoted social equality in the villages.[30] Supporters claim that Operation Flood has resulted in increased incomes for lower caste households, which are among the poorest in India.

Each of these views and the myriad subdivisions within them offer many hypotheses; few, however, have been tested. Thus there is less data than logic in many of the arguments both for and against Operation Flood. Supporters and critics both base their arguments on hypothesized benefits or negative effects and are unable to confirm or deny whether these changes have been realized.

In the following chapters, after a brief review of the history and structure of the Indian dairy cooperative movement, these views and the evidence used to support them are discussed in more detail. By way of background information, studies and evidence intended to identify the constraints to dairy development at the national level are examined. Research and investigations aimed at measuring the farm-level impact on production of Operation Flood are then reviewed, and welfare, income distribution, and nutritional matters are discussed. Finally, some general conclusions and microeconomic research priorities are presented.

It should be noted that the authors concentrate on Operation Flood because it is the largest and most controversial dairy development program in India. It is not, however, the only program. Total milk production in India increased at a rate of 5.5 percent a year between 1970 and 1985, yet only 6.0 percent of total milk production was handled through cooperatives at the end of this period. Thus it is clear that progress must be occurring throughout the sector. Since the strategy followed by Operation Flood is considered a model, the authors concentrate on its evaluation. The reader, however, should also consider the debate in terms of dairy development as a whole.

NOTES

[1]See, for example, John W. Mellor, The New Economics of Growth (Ithaca, N.Y.: Cornell University Press, 1976).

[2]Raymond Crotty, Cattle, Economics, and Development (Oxford: The Gresham Press, 1980), especially Chapter 11; and P. John, Economics of Dairy Development in India (Digha Chat, Patna, India: Prabhat Prakashan, 1975).

[3]For estimates of Indian expenditure and price elasticities for milk and milk products, see R. Radhakrishna and K. N. Murty, Models of Complete Expenditure Systems for India (Laxenburg, Austria: International Institute of Applied Systems Analysis, 1980).

[4]Martin Doornbos and Manoshi Mitra, Politics of International Dairy Aid: International Interest and the White Revolution, Working Paper on Dairy Aid and Development, Series No. 1 (The Hague: Institute of Social Studies, 1985); Michael Lipton, "Indian Agricultural Development and African Food Strategies: A Role for the EC," in India and the EC, ed. W. Caliewaert (Brussels: Center for European Policy Studies, 1985); and Peter J. Brumby and R. G. Scholtens, "Management and Health Constraints for Small-Scale Dairy Production in Africa, Bulletin 25 (Addis Ababa: International Livestock Centre for Africa, August 1986).

[5]World Food Programme, Detailed Report of the Second World Food Programme Evaluation Mission on Operation Flood (New Delhi: Indian Dairy Corporation, 1976); World Food Programme, Terminal Evaluation Report on Project India 618--Milk Marketing and Dairy Development, Operation Flood I (New Delhi: WFP, September 1981); World Bank, India: National Dairy Development Project, Staff Appraisal Report (Washington, D.C.: World Bank, May 1978); India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II (New Delhi: MOA, 1985).

[6]Shanti George, "Faulty Lactometers - II: World Food Programme, World Bank, and Jha Committee Evaluations of Operation Flood." Economic and Political Weekly (June 1986).

[7]B. S. Baviskar, "Operation Flood and Social Science Research," Economic and Political Weekly (January 1984): 94-96.

[8]Mogens Jul, personal communication (1986).

[9]Shanti George, "Operation Flood and Rural India: Vested and Divested Interests," Economic and Political Weekly (December 1985): 2163-2170; and K. T. Achaya and Vinod K. Huria, "Rural Poverty and Operation Flood," Economic and Political Weekly (September 1986): 1651-1656.

[10]See, for example, Claude Alvarez, "Operation Flood: The White Lie," The Illustrated Weekly of India (October 1983); V. Kurien, A Black Lie (Gomdi-Anand, India: Anand Press, 1984); and B. S. Baviskar and Shanti George, "Operation Flood: A Different View," Economic and Political Weekly (November 1986): 161-62.

[11]A. K. Gupta, "Farmers' Response to Cooperative Project Implementation: Cases in Dairy and Pasture Development in Arid Regions," Center for Management in Agriculture, Indian Institute of Management, Ahmedabad, India, 1981.

[12]Surendar Singh, "Operation Flood II: Some Constraints and Implications," Economic and Political Weekly (October 1979): 1765-1774.

[13]Bharat Dogra, "Not Such a Flood," Economic and Political Weekly (May 1982): 817.

[14]S. Chatterjee, Aid, Trade, and Rural Development: A Review of New Zealand's Assistance to Indian Dairying, Working Paper on Dairy Development, Series No. 3 (The Hague: Institute of Social Studies, 1985).

[15]Mogens Jul, "Comments on Operation Flood, 1985," Department of Food Preservation, Royal Veterinary and Agricultural University, Fredericksburg, Denmark, May 1986 (mimeographed), p. 26; and Indian Dairy Corporation, Fifteenth Annual Report 1984-85 (Gomdi-Anand, India: Anand Press, 1985).

[16]See, for example, Chatterjee, Aid, Trade, and Rural Development.

[17]Frank van Dorsten, The Rural Impact of Operation Flood: Viewpoints and Hypotheses, Working Paper on Dairy Aid and Development, Series No. 4 (The Hague: Institute of Social Studies, 1985).

[18]Shanti George, "Cooperatives and Indian Dairy Policy: More Anand than Pattern," in Cooperatives and Rural Development, ed. Donald W. Attwood and B. S. Baviskar (Delhi: Oxford University Press, 1983).

[19]Shanti George, "Faulty Lactometers - I: Village Level Evaluations of Operation Flood," Economic and Political Weekly (May 1986): 963-971; and S. M. Patel and M. K. Pandey, Economic Impact of Kaira District Cooperative Milk Producers Union (Amul Dairy) in Rural Areas of Kaira District (Gujarat State) (Ahmedabad: Institute of Cooperative Management, 1976).

[20]Crotty, Cattle, Economics, and Development.

[21]Chatterjee, Aid, Trade, and Rural Development.

[22]India, National Commission on Agriculture, Interim Report of the National Commission on Agriculture on Milk Production through Small and Marginal Farmers and Agricultural Laborers (New Delhi: NCA, 1971).

[23]Martin Doornbos et al., Operation Flood as a Food Strategy: Socioeconomic Implications and Issues for Research, Working Paper on Dairy Aid and Development, Series No. 2 (The Hague: Institute of Social Studies, 1985).

[24]Mogens Jul, "Unexpected Benefits from a Dairy Project," Food and Nutrition Bulletin 1 (No. 3, May 1979): 15-19.

[25]Mogens Jul, "The Contribution of the Post-Harvest Food System to Employment Generation and Nutritional Improvement: Case Studies of the Potential of Dairy Technologies," Food and Nutrition Bulletin 7 (No. 2, June 1985): 14-20.

[26]World Food Programme, "Milk Marketing and Dairy Development."

[27]Indian Dairy Corporation, Fifteenth Annual Report 1984-85.

[28]Jul, "The Contribution of the Post-Harvest Food System."

[29]Tushaar Shah, "Economic Impact of Operation Flood: Report on a Detailed Survey of Six Villages," Institute of Rural Management, Anand, India, 1983 (mimeographed); and Achaya and Huria, "Rural Poverty and Operation Flood."

[30]A. H. Somjee and Geeta Somjee, "Cooperative Dairying and the Profiles of Social Change in India," Economic Development and Cultural Change (1978): 577-590.

2. THE HISTORY OF AMUL, THE DAIRY COOPERATIVE MOVEMENT, AND OPERATION FLOOD

The present Indian dairy cooperative system has its origin in events that took place in Kaira district in preindependence India. Before the establishment of a dairy cooperative in Kaira district (part of present-day Gujarat), the rural milk economy operated as a subsystem within the total agricultural economy, and in most villages of the district it constituted an auxiliary source of income for the farmer.[1] Dairying was constrained by inadequate marketing channels and by the absence of modern inputs such as balanced cattle feed, artificial insemination, and scientific animal husbandry practices. A large proportion of the dairy animals in the area consisted of buffalo because buffalo milk brought a better price than cow milk. This is explained by the practice of determining the price of milk on the basis of fat content--buffalo milk is high in fat. The rural milk economy was also constrained by an inability to exploit the seasonal peaks in the production of milk. The flush season for milk is the winter months, but inadequate facilities for conversion to milk powder or other products prevented the conservation of surplus milk. Farmers were compelled to consume surplus milk or convert it into ghee (a form of butter), the sale of which brought a lower return.

Singh and Kelley contend that before 1976 the dairy industry in Kaira was an exploitive market in which traders were able to influence the price to their own advantage.[2] They further state that manufacturers of dairy products also took advantage of the weak bargaining position of producers by fixing a low purchase price for milk.[3] Similar assertions are made by Baviskar. However, no evidence to prove these allegations is cited by these authors.

In 1946, the Bombay Milk Scheme, a government agency, awarded Polson, a private manufacturer in Anand, the monopoly right to collect milk from 14 villages in Kaira district. Polson also received the right to process the milk and dispatch it to Bombay.[4] The scheme's decision met with protests from other private manufacturers, small milk merchants, and rural producers. Resistance to the government's resolution emerged. Led by T. K. Patel, a local social worker, the farmers decided to organize a producers' cooperative and to establish independent access to the urban market in Bombay. The Kaira District Cooperative Milk Producers' Union, Ltd. (KDCMPU) was registered on December 4, 1946.

Following the establishment of KDCMPU, the Government of Bombay agreed to purchase a part of its milk from the union. Substantial financial assistance and the provision of equipment by the Government

of Bombay and the Bombay Milk Scheme allowed KDCMPU to increase fluid milk sales in Bombay. From 1946 to 1951, however, the policies of KDCMPU were directed toward obtaining monopoly rights over the sale of milk to the Bombay Milk Scheme. As a result of effective political lobbying by the union leadership, these rights were obtained in 1952.[5] Subsequently, state and national political leaders, like Morarji Desai and Dinker Rao Desai, supported the activities of KDCMPU and were helpful in soliciting further support from the Government of India. KDCMPU was also patronized by Sardar Patel, the deputy prime minister of India.

Despite the political influence commanded by KDCMPU, it was unable to prevent the Bombay Milk Scheme from establishing the Aarey Milk Colony for the city's privately owned buffalo, and thus securing for itself a captive supply of locally produced milk.[6] The union was thus confronted with seasonal surpluses. To absorb the growing surplus of milk, KDCMPU was forced to diversify its products.

The manufacturing arm of the dairy industry in the mid-1950s was oligopolistic, with a few firms controlling a major share of the market. Most were subsidiaries of, or operated in collaboration with, foreign firms and imported their products from countries with a comparative cost advantage in the manufacture of dairy products.[7] Prices of these products were low and KDCMPU could not easily break into the market. Effective political lobbying by KDCMPU leaders resulted in import quotas for dairy products. The resulting fall in supply, accompanied by a rising demand due to population growth, rising incomes, and changing tastes, led to an increase in the prices of manufactured dairy products.

In the next few years, it became more profitable for KDCMPU to manufacture dairy products. Moreover, in the 1950s KDCMPU began to obtain milk powder provided as food aid. This was inexpensive and became a regular input into its production process. The union continued to expand its plant capacity with financial aid from the Bombay Milk Scheme and the Government of Bombay. International agencies such as the Oxford Committee for Famine Relief (OXFAM), the United Nations Children's Fund (UNICEF), and the World Food Programme (WFP) also provided aid to KDCMPU to expand its machinery and to establish feed mix plants, artificial insemination, and veterinary services.

The division of the State of Bombay in 1960 into the states of Maharashtra (including Bombay) and Gujarat (including Anand) severed the political link between KDCMPU and the Bombay Milk Scheme. The latter ceased to be a major source of external capital for the union. It was replaced by the Government of India, which hoped that an expansion of the dairy product industry would help to promote economic growth and domestic ownership of resources and perceived KDCMPU to be the only major Indian firm in the industry.[8]

The Government of India created the National Dairy Development Board (NDDB) in 1964 to guide and coordinate the development of the dairy industry. Its official aim was to replicate KDCMPU's pattern of cooperative dairying throughout India under a comprehensive program of dairy development known as Operation Flood. To build up its own capabilities, the NDDB borrowed personnel from KDCMPU; for example, Dr. V. Kurien, who was its general manager, was appointed chairman of the NDDB. The Indian Dairy Corporation (IDC) was set up in 1970 to complement the activities of the NDDB. The IDC, also headed by Kurien, was to control the receipt and sales of donated dairy commodities. Together, the IDC and NDDB were given, and still have, the responsibility for overall coordination and implementation of Operation Flood.

Operation Flood was designed by national planners to create a "flood" of milk by helping rural producers to organize village dairy cooperatives on the pattern of Anand,[9] thereby gaining access to and control over a network of milk-processing facilities, and finally the urban market.[10] Large-scale food aid (mainly skim-milk powder) from the European Economic Community (EEC) and loans from the World Bank's International Development Association (IDA) have made the two phases of Operation Flood the largest dairy development scheme in the world. It is also the largest single recipient of EEC aid to developing countries. The magnitude of this operation and its implications for future rural development strategy in India have prompted widespread questioning of the organizational framework and the institutions comprising the dairy cooperative movement.

Operation Flood I was launched in 1970 and financed by donations of surplus dairy commodities from the EEC channeled through the World Food Programme. By the end of the first phase in 1981, the EEC had provided aid to the value of U.S. $150 million. The main objective of Operation Flood I was to meet most of the demand for fluid milk in the four metropolitan cities of Bombay, Calcutta, Madras, and New Delhi by supplying milk from 18 rural milksheds--comprising 12,000 village cooperatives organized into 27 district unions--in 10 states. The target was to form village cooperatives representing one million milk-producing households owning over 1.9 million milk animals.

In 1979, before the completion of phase I, Operation Flood II was launched. Based, as before, on EEC-donated dairy surplus commodities and an IDA loan, Operation Flood II is a similarly ambitious program involving a total investment of Rs 4.9 billion. The objective is to extend the dairy cooperative structure to serve approximately 10 million rural milk-producing households by organizing 40,000 village cooperatives and 155 district unions in 18 states and union territories. In the event, there were many delays and some increases in the planned coverage, with some of the goals of Operation Flood II incorporated into phase III, which is being planned.

The present policy of Operation Flood is based on the replication of the "Anand Pattern" of cooperative dairying.[11] The pattern is a

representative model of the institutional framework of the Anand Milk Producers Union, Ltd. (AMUL). This dairy cooperative in Anand consists of three tiers. The first is the Village Milk Producer's Cooperatives, each of which is a member of one of the Cooperative Milk Producers' Unions, which form the second tier. The third tier, added in the second phase of Operation Flood, is a State Cooperative Milk Marketing Federation through which the unions can undertake joint marketing programs.[12] This too was based on the earlier experience of Gujarat.[13]

Under the maintained hypothesis that AMUL has been locally successful, the policy of replicating AMUL raises at least three questions regarding the structure and organization of the dairy cooperative movement. First, given the unique political, social, and geographical conditions that surrounded AMUL's origins and eventual success, can the Anand Pattern be replicated in areas where those conditions are largely absent or noticeably less favorable? Second, does Operation Flood faithfully replicate the original model of cooperative dairying in Anand? At the heart of this question is the extent to which the original cooperative concept is preserved and developed by the present organizational structure. Third, is Anand necessarily the ideal model for fostering the expansion of dairy development in India? The essence of this question is the search (or lack of one) for alternatives to the cooperative structure.

CAN THE ANAND PATTERN BE REPLICATED?

Given the unusually favorable circumstances responsible for the success of the AMUL dairy cooperative, several critics point out the limits to the replication of this pattern in areas where successful dairying is contingent upon a similar set of factors. George explains that the question of replication would be simple if AMUL had been the result of official planning based on the provision of standard repeatable inputs.[14] Instead, the AMUL cooperative emerged spontaneously as a movement of dairy farmers who organized themselves in an effort to protect and improve their market position. Thus, George maintains, KDCMPU was the result rather than the cause of successful dairying, since the latter existed before the formation of KDCMPU.

Patel and George also state that the Kaira district has the advantage of geographical proximity to the huge urban milk market in Bombay.[15] Effective links to this market for milk were originally developed in the nineteenth century as a result of the expansion of the railway. Subsequently the district became a major center for the manufacture of dairy products, especially during World War II. According to George, similar market linkages often are not found in other areas of the country, and therefore the replication of Anand's marketing network cannot be expected to be so successful in areas without developed links to an urban market. George, however, may underestimate the gain to be realized by establishing both local and long-distance market links where previously there were few or none.

Several studies have established that AMUL developed in a political climate conducive to its interests. According to Singh and Kelley, George, Patel and Pandey, and Somjee and Somjee, the local leadership of Kaira district was instrumental in mobilizing milk producers in the villages to form and operate a network of cooperative societies.[16] The formation of AMUL in 1946 and its subsequent expansion can be attributed to the efforts of local leaders, most of whom belonged to the dominant Patel caste. After its inception, many local leaders rose to become leaders of the union. Thus the management of the union consisted, and still does consist, primarily of Patels. They have been able to obtain assistance for the union from members of their community who occupy leadership positions at the local, state, and national levels. Singh and Kelley describe their successful lobbying, which resulted in the union's monopoly of milk collection in Anand and financial assistance from the government. Patel and George argue that the absence of a similar political history will detract from the success of other dairy cooperative societies. George is explicit, stating that the average dairy cooperative society cannot hope to achieve AMUL's success without the political protection that was enjoyed by the latter.

George contends that the initial production environment must be favorable for the successful replication of the Anand Pattern. Anand is located in one of the most fertile areas of Gujarat. A majority of the bovine population consists of buffalo. Therefore, George argues, the same success cannot be obtained in areas where local cows are the common dairy animal or where fodder supplies and grazing are inadequate.

The effective organization of demand is also a prerequisite for the replication of the Anand model. George supports this assertion by referring to the market link between the Bombay Milk Scheme and the union. She suggests that it is unlikely that the union would have performed as well in an unregulated market where it would have had to compete with private industry. By providing the union with a quota, the Bombay Milk Scheme protected the union from competition. Similar protective measures have not been implemented in other areas. Nyholm et al. observed that dairy cooperative societies in the Bangalore milkshed area did not achieve higher levels of production, despite substantial demand. They attributed this, in part, to the absence of organized markets. The dairy cooperative societies had to compete with the private trade in meeting the demand for milk in Bangalore. Often the two market systems were integrated, thus negating the cooperative movements' objective of providing an alternative to the traditional system of milk marketing.[17]

Attwood and Baviskar support the view that Operation Flood may not be able to successfully replicate the Anand Pattern of dairying because the program is constrained by the absence of inputs that contributed to Anand's success.[18] They contend, however, that the absence of these factors can be ameliorated by administrative support from the government and the presence of a successful model ready to be copied. Others

attribute to Operation Flood a desire to break the traditional dairy trade and claim that this may be harmful to the poor.[19] Some of these points are echoed in the Jha Report, which also emphasizes the diversity of state government commitment and performance in implementing Operation Flood. The same report also speaks of unrealistic expectations:

> To hope, that in districts whose milk supply potential had not been fully developed, where the cooperative movement was unknown and where marketing through middlemen and private trade was well entrenched, another Anand could be created in less than a decade was to expect the impossible.[20]

IS THE ORIGINAL ANAND MODEL BEING REPLICATED?

The AMUL dairy in Anand was organized as a cooperative to ensure the participation of all rural producers in the process of dairy development. Small farmers, landless laborers, women, and the lower castes were to be the major beneficiaries within a cooperative scheme of dairying. With this in mind, India's dairy planners sought to replicate the original Anand model under Operation Flood. Several studies have questioned the extent to which the ideals of the original cooperative concept have been preserved and developed by the present organizational structure of Operation Flood. Most such arguments appear, however, to overlook the fact that Operation Flood was and is primarily a milk production and marketing strategy.

Somjee and Somjee applaud the dairy cooperatives for cutting across caste barriers and giving the lower castes a chance to participate in the dairy cooperative movement.[21] According to their study, the lower castes have been the greatest beneficiaries of cooperative dairying. Once allowed equal access to the market through the dairy cooperatives, these underprivileged groups became substantial producers of milk. Similar views are expressed by Apte and Patel.[22] The Indian Dairy Corporation reports that over 70 percent of the members of cooperative societies are from the economically backward classes.[23] George has attacked the belief that AMUL is a noncasteist institution and says that the dominance of the Patel community in the management of the cooperative negates the very spirit of cooperation.[24] She accuses AMUL of retaining caste affiliations with the Patel community and discouraging lower castes from enrolling in the membership of the cooperatives. George supports these statements by referencing two studies by Bhat and Dogra,[25] but there are no data cited in these references to provide firm evidence. Joshi implicitly supports George by claiming that different castes will not cooperate on an equal basis.[26] Assertions, without evidence, concerning the failure of dairy cooperatives to reduce inequality of either caste or class are also made by Baviskar and Attwood.[27] Jodha recognizes that this may be the result of traditional, inegalitarian village social structures.[28] Dorsten suggests that the inability of the dairy cooperatives to advance credit to mem-

bers makes it difficult for them to function as poor men's organizations, a point repeated by George.[29]

Jul basically accepts these arguments and agrees that the ideal model advocated by Operation Flood has not been replicated.[30] He points out that the society secretary and milk tester are sometimes elected through the caste system and that nepotism and other abuses often intrude, but that it would be unrealistic to expect Operation Flood to achieve changes in rural cultural patterns in such a short period.

These arguments point to a major difficulty in evaluating the social consequences of the cooperative movement. If the objective is to establish autonomous farmers' organizations, those organizations are likely to reflect the economic, caste, and sex biases of the community. Where the poor are not organized in this "normal" situation, it is unrealistic to expect that the formation of a new village committee will change the situation. If, on the other hand, the cooperatives are to act as agents of change, providing resources to the poor and new opportunities for power sharing, it is unlikely that they will be autonomous self-sustaining village organizations, because this would conflict with the normal situation. So, if the cooperatives are expected to be reformist, greater support from, and hence control by, government is implied.

The same issue can be seen in the arguments about the role of women. Supporters' claims perhaps lead to unrealistic and inappropriate goals for a producers' cooperative movement. According to Somjee and Somjee, the dairy cooperatives have increased participation by women.[31] Their study indicates that the social change effected by cooperative dairying has influenced the community by allowing women to assume leadership positions in dairy cooperative societies. The institutional recognition awarded to women, they claim, is unusual but reflects the growing trend of social equality fostered by cooperatives. The contrary, however, is claimed by Singh, Jain, and Chand, who assert, on the basis of a survey in Kaira district, Gujarat, that women are marginal participants in dairy cooperatives.[32] Apte claims that the low numbers of women on dairy cooperative society membership rolls reflects an inequity in the distribution of the benefits of cooperative dairying. He attributes the lower participation of women in dairy cooperative societies to a regulation that restricts membership to one person per family. The (apparent) contribution of females to dairying is restricted by this practice.[33] A 1983 study by Mitra also notes that it is usually the men who are registered as members of the cooperative and that this impedes women's access to dairy income.[34] Speaking more generally, one commentator states that women are not a significant part of the cooperative structure.[35] She also notes, however, that the NDDB is favorably disposed toward increasing the participation of women and that there are some cooperatives where women play an important role both as members and managers.

Cooperatives require their members to exercise control over the working of the society. According to Attwood and Baviskar, part of AMUL's success results from joint and cooperative decisionmaking by the members, thus retaining the original organizational structure of a cooperative. But a similar trend has not been observed for other dairy cooperative societies modeled on the AMUL pattern. Attwood and Baviskar claim that the NDDB and the IDC, created by the Indian government to "guide and coordinate the accelerated development of the dairy industry," have stifled local initiative by implementing new dairy schemes through a process of centralized planning, and that a highly bureaucratized structure has evolved with the decisionmaking process controlled by the NDDB.[36] Others see this being perpetuated indefinitely because of the control that the NDDB and IDC have over capital and aid allocations.[37] These critics, however, probably underestimate the role of state governments, which, under the Indian constitution, are autonomous agents in agricultural and dairy policy.

Baviskar, in a later paper, comments that with expansion under Operation Flood, the cooperative principles of AMUL have been compromised.[38] He claims that AMUL's cooperative structure has not been preserved. Instead of directly influencing policymaking, members now play a subsidiary role to managers and technocrats who have assumed control over the working of the cooperatives. According to Baviskar, the present organizational structure increases the power of the lower levels of the bureaucracy.

The boards of directors of the unions are the major policymaking bodies. Unlike the sugar cooperatives in Maharashtra, these directors are indirectly elected by a nominated representative of each dairy cooperative society. Thus the directors are only indirectly elected by the membership of the village cooperative societies. Baviskar claims that this prevents members from directly influencing policymaking. The lack of contact between directors and producers prevents the directors from understanding the intricacies of the union's operation and increases their reliance on managers and technocrats.[39]

Most critics, however, fail to mention other important factors that have influenced replication. These factors are well summarized in the Jha Report, which states

> ...in some States it became necessary to set up a federation in the first instance in order to take up the responsibility of forming cooperatives and unions for implementing the project. This attempt to build up the Cooperative structure from the top rather than the bottom was fraught with difficulties, particularly in States where there was no tradition of a healthy cooperative movement.... Competition from the private sector was also often intense and there were disagreements between IDC and the State Governments on how to proceed. Moreover, ...in some instances (States)...the Anand pattern was accepted, without any genuine commitment to it....[40]

IS ANAND THE IDEAL MODEL FOR DAIRY DEVELOPMENT?

The issues regarding the cooperative nature of the present organizational structure based on the AMUL pattern are commonly followed by questions about the validity of AMUL as the ideal model for dairy development.

George criticizes AMUL for operating as a joint stock company rather than a cooperative society and claims this criticism to be justified by observing the low price paid to the producer. She claims that AMUL allocates only a small share of its profits to producers in the form of dividends and a bonus, retaining a majority of the earnings to build up capital reserves for future investment. Singh and Kelly offer support for George's statements by maintaining that retained earnings could have been used by the dairy cooperative societies to pay a higher price for milk. The price received by producers, George claims, is insufficient to cover the costs of production. But George's argument is unconvincing, since producers would be unlikely to continue to sell milk to AMUL if this were so.[41]

Others question whether the cooperatives modeled on Anand are competitive with the private trade.[42] However, Lele suggests that the Anand cooperative established its superiority over the private trade by offering better services to milk producers.[43] However, the Institute of Rural Management, Anand (IRMA) observes that private milk traders continue to operate successfully in competition with dairy cooperative societies, particularly in areas that are close to a market.[44] Private traders also compete among themselves. This competition creates upward pressure on producer prices and narrows the margin of profit for the trader. To increase their purchases, private traders often offer credit to producers.[45] These loans are repaid by producers accepting lower milk prices from the traders.[46] Such competition in the credit market should, however, be seen as a component of price competition. But under the Anand pattern, dairy cooperative societies are prohibited from advancing credit on their own account.[47] In Karnataka, however, it seems that unofficial credit is provided by the leaders of the societies, who thus capture some of the supply for the societies and make a personal profit.[48] Since the income of a dairy cooperative society depends on the amount of milk delivered, such unofficial loans, the same writers argue, tend to be granted selectively to members who regularly deliver milk to a society and form an important part of the competition with private buyers.

The Jha Report, although recognizing that the formation of dairy cooperative societies is highly desirable, recognizes that it may not be the best strategy, at least initially, in areas where milk production is relatively underdeveloped.[49] Instead, the report argues that much prior development work is necessary to create the marketable surpluses that will make a cooperative structure profitable.

Some commentators argue that Operation Flood has failed to consider seriously the possibility of upgrading household technologies for making traditional milk products and hence the development of technologies to make small-scale factory processing feasible.[50] They see such approaches as an antidote to the capital intensity of Operation Flood. Data indicating the optimal economic scale of such enterprises are almost nonexistent. Often, due to ideology and the legacy of Mahatma Gandhi, cottage industries are maintained with government subsidies.

The studies reviewed above purport to answer the three questions raised earlier about the organizational structure of the cooperative movement. Although these studies claim to be empirical, the absence of convincing data to justify their arguments is a major constraint. These questions thus remain open to further analysis.

NOTES

[1]Somjee and Somjee, "Cooperative Dairying."

[2]S. P. Singh and Paul Kelley, AMUL: An Experiment in Rural Economic Development (New Delhi: Macmillan, 1981).

[3]B. S. Baviskar, "Milk and Sugar: A Comparative Analysis of Cooperative Politics," Institute of Development Studies, Sussex, United Kingdom, 1984 (mimeographed).

[4]Singh and Kelley, AMUL: An Experiment in Rural Economic Development.

[5]Ibid.

[6]Michael Halse, "Producing an Adequate National Diet in India: Issues Relating to Conversion Efficiency and Dairying," Agricultural Systems (No. 4, 1979): 239-278.

[7]Singh and Kelley, AMUL: An Experiment in Rural Economic Development.

[8]Ibid.

[9]Katar Singh and V. Mukunda Das, "Impact of Operation Flood I at the Village Level," Institute of Rural Management, Anand, India, 1982 (mimeographed).

[10]Piet Terhal and Martin Doornbos, "Operation Flood: Development and Commercialization," Food Policy 8 (August 1983): 235-239.

[11]National Dairy Development Board, Operation Flood: A Proposal (Anand, India: NDDB, 1977).

[12]Michael Halse, "Increasing the Incomes of Landless Laborers and Small Holders: The Experience of India's Dairy Cooperatives, Parts I and II," Agricultural Administration 15 (1980): 259-272.

[13]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II (New Delhi: MOA, 1985).

[14]George, "Cooperatives and Indian Dairy Policy."

[15]A. S. Patel, "Cooperative Dairying and Rural Development: A Case Study of Amul," paper presented at the Symposium on Cooperative and Rural Development, University of Montreal, Quebec, 1983 (mimeographed); and George, "Cooperatives and Indian Dairy Policy."

[16]Singh and Kelley, AMUL: An Experiment in Rural Economic Development; George, "Cooperatives and Indian Dairy Policy"; Patel and Pandey, Economic Impact of Kaira District Cooperative Milk Producers Union; and Somjee and Somjee, "Cooperative Dairying and the Profiles of Social Change in India."

[17]Klaus Nyholm, Henrik Schaumberg-Muller, and Kirsten Westergard, "Socioeconomic Aspects of Dairy Development, Report from the Bangalore Milkshed Area," Economic and Political Weekly (December 1974): A127-136.

[18]B. S. Baviskar and Donald W. Attwood, "Rural Cooperatives in India: A Comparative Analysis of Economic Survival and Social Impact," paper presented at the Symposium on Cooperatives and Rural Development, University of Montreal, Quebec, 1983 (mimeographed).

[19]Doornbos et al., Operation Flood as a Food Strategy.

[20]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II, p. 22.

[21]Somjee and Somjee, "Cooperative Dairying and the Profiles of Social Change in India."

[22]D. P. Apte, "Role of Cooperative Dairy Development Schemes in Rural Development," paper presented at the Symposium on Cooperatives and Rural Development, University of Montreal, Quebec, 1983 (mimeographed); and S. Patel, "The 'Anand' Pattern: A Socio-Historical Analysis of its Origin and Growth," paper submitted to the IDPAD Project of the Institute of Social Studies, The Hague, 1984 (mimeographed).

[23]Indian Dairy Corporation, Fifteenth Annual Report 1984-85.

[24]George, "Cooperatives and Indian Dairy Policy."

[25]M. L. Bhat, "Economic Survey of Borsod Taluka (Gujarat State) with Special Reference to the Impact of Community Development Program," Agroeconomic Research Center, Vallabh, Vidyanagar, India, 1966 (mimeographed); and Bharat Dogra, "The White Revolution: Who Gets the Cream?" The Economic Scene (No. 7, 1981): 10-19.

[26]V. H. Joshi, "Operation Flood and the Rural Poor," Institute of Development Studies, Sussex, United Kingdom, 1983 (mimeographed).

[27]Baviskar and Attwood, "Rural Cooperatives in India."

[28]N. S. Jodha, "Special Programs for the Rural Poor, the Constraining Network," Economic and Political Weekly (March 1973): 633-639.

[29]van Dorsten, The Rural Impact of Operation Flood; and George, "Operation Flood and Rural India."

[30]Jul, "Comments on Operation Flood, 1985," pp. 12-13.

[31]Somjee and Somjee, "Cooperative Dairying." See also Asian and Pacific Center for Women and Development, "Impact on Women: The Anand Pattern of Dairy Development," in Section 5 of Women's Employment--Possibilities of Relevant Research (Anand, India: Research and Development Department, National Dairy Development Board, 1979).

[32]N. Singh, D. Jain, and M. Chand, "Milkmaids of Kaira District: Some Notes," Institute of Social Studies, New Delhi, 1979 (mimeographed).

[33]Apte, "Role of Cooperative Dairy Development Schemes."

[34]M. Mitra, A Study of Women in Dairying in Andhra Pradesh. Report of a Baseline Survey (New Delhi: July 1983).

[35]Devaki Jain, "Women, Food, and Technology: A Comment," Economic and Political Weekly (March 1980): 530-532.

[36]Baviskar and Attwood, "Rural Cooperatives in India"; Terhal and Doornbos, "Operation Flood," p. 233; and P. R. Gupta, ed., Dairy India 1983 (New Delhi, India: Rekha Printers, 1983).

[37]Doornbos et al., Operation Flood as a Food Strategy.

[38]Baviskar, "Milk and Sugar."

[39]Ibid.

[40]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II, p. 78.

[41]George, "Cooperatives and Indian Dairy Policy"; Singh and Kelley, AMUL: An Experiment in Rural Economic Development.

[42]Doornbos et al., Operation Flood as a Food Strategy.

[43]Uma Lele, "Cooperatives and the Poor: A Comparative Perspective," World Development 9 (1981): 55-72.

[44]Institute of Rural Management, Anand, "Profiles in Development: Operation Flood I at the Village Level: A Preliminary Summary of Results," IRMA, Anand, India, February 1981 (mimeographed).

[45]Nyholm et al., "Socioeconomic Aspects of Dairy Development"; and India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[46]Nyholm et al., "Socioeconomic Aspects of Dairy Development."

[47]Baviskar, "Milk and Sugar"; India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[48]Nyholm et al., "Socioeconomic Aspects of Dairy Development."

[49]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[50]Doornbos et al., Operation Flood as a Food Strategy.

3. SOME AGGREGATE CONSTRAINTS TO DAIRY EXPANSION

During the preparation of Operation Flood II, the strategies underlying the whole of Operation Flood were reviewed. It seems that three production strategies were given particular consideration (Table 1).

Table 1--Alternative strategies for increasing annual milk production to 38 million metric tons

Strategy	Feedstuffs Required Annually, "As Fed" Wet Weight		
	Dry Fodder	Green Fodder/ Natural Herbage	Concentrates
	(millions of metric tons)		
Keeping size of national herd constant and increasing feed inputs per milk animal	147.2	209.6	23.6
Increasing size of national herd and keeping feed inputs per milk animal constant	179.6	388.2	20.2
Keeping size of national herd constant, replacing 10.2 million local milk animals by the same number of genetically improved animals, and feeding each group at economic rates	130.1	309.2	19.2

Source: National Dairy Development Board, Breeding and Feeding for Milk Production in Operation Flood II (Anand, India: NDDB, September 1980).

The first strategy in Table 1 was rejected because it required farmers to feed animals above the economically optimal point, thereby reducing farm-level profits. The second was rejected because it would

have required a greater quantity, compared to the third, of all types of feed inputs.[1]

The third strategy was accepted and relies mainly on increasing the pace of technological change. It is analogous to industrial retooling in which outdated capital is replaced by newer, more productive assets. This strategy represents a departure from traditional practices. The speed with which crossbred technology is being adopted should not be exaggerated. Achaya and Huria, citing NDDB figures, show that in 1984, 6.4 percent of a total population of 9 million milk animals in Operation Flood milksheds were crossbreds. Moreover, Operation Flood milksheds covered no more than 12 percent of the total national milk animal population.[2] Echoing these claims, the Jha Report states that progress with the artificial insemination program has been inadequate, with low conception rates and low numbers of live births.[3]

In general, farmers in India keep cows in order to produce bullocks for draft power, with milk being produced only as a by-product.[4] John emphasizes the low standards of traditional cattle management in India.[5] Traditionally, cows are not selected for their milk yield. Buffalo, on the other hand, are seldom kept for draft power, providing instead most of the milk consumed by people.[6] This chapter discusses the more important constraints to the chosen strategy when viewed nationally.

CONSTRAINTS ON FEED SUPPLY

A number of studies have pointed out present and forseeable shortages of feed and fodder in India and the implications for dairy development.[7] They claim that the feed shortage results from limited supplies of crop residues and a fodder shortage and is also closely related to overall land availability. These claims are partially endorsed in the Jha Report, which states that an energetic program of fodder production is necessary.[8]

According to Shah, Tripathi, and Desai, the country's available feed resources are not sufficient to meet the scientifically estimated feed requirements of the existing herd.[9] They argue that even if sufficient feed resources were available, farmers would be unlikely to feed their milk animals at scientifically determined (biologically optimal) feeding rates. It is more reasonable, they claim, to expect farmers to feed their animals at "economic feeding rates," which may not enable the milk animals to produce at levels that match their genetic potential but will maximize financial returns to milk production. Using the present composition of the national herd, current feeding rates, and recognizing the current predominance of local buffalo and other nondescript breeds with low genetic potential and poor feed-conversion efficiency, they show that the share of concentrates and cultivated green fodder in the national feed bill is much

smaller than that of crop residues and natural herbage. They claim the NDDB is correct in assuming that there appears to be no reason why the rates at which milk producers feed their milking animals should not be very close to the economic feeding rate as defined above. If it were profitable to feed milking animals better, farmers would have the wisdom to do so.[10]

The major issue facing the dairy industry's planners is the determination of the best policy for meeting the growing demand for milk within the constraints imposed by limited feed and fodder availability.[11] Shah et al. discuss the alternative of replacing roughage and crop residues by concentrates.[12] Concentrates are relatively expensive per unit of energy or protein and are not economical when fed to indigenous stock at current milk prices. Thus, increased milk production can be achieved by allowing milk prices to rise, or alternatively, by introducing animals that convert expensive concentrates to milk more efficiently. The NDDB has partially adopted the latter option in Operation Flood by following the third strategy in Table 1.

The strategy underlying Operation Flood II is to evolve a milk animal population so structured that it permits existing low-yielding animals to continue to produce whatever milk and draft power they can, by being fed mainly on relatively abundant crop residues and natural herbage, and to enable a relatively small herd of high-yielding animals to convert the scarce feeds (for example, green fodder and concentrates) into milk more efficiently. Operation Flood had hoped that by 1984-85 the national milk herd (NMH) would contain 10.2 million crossbred cows and improved buffalo, replacing an equal number of local animals, and that the NMH should constitute about 11 percent of the milk animal population, consuming about 21 percent of the available concentrates, 8 percent of the green fodder, and 7 percent of the dry fodder, and contribute one-third of national milk production.[13] The same NDDB report estimated that by 1984-85, 21.3 million tons of concentrate feed would be available. According to the strategy of Operation Flood II, the NMH would be fed 5.9 million tons of the available concentrate feed. This implies that the NMH would consume 27.5 percent of the available concentrates and not 20.75 percent as stated earlier in the same report.

Nair and Jackson, in challenging the strategy of Operation Flood II and using the figures in the NDDB report, claim that the strategy of Operation Flood II calls for about 19 million tons (about 93 percent) out of a total of 20.5 million tons of available concentrates to be fed to the NMH.[14] The NDDB report refers to 19 million tons as the amount available in 1984-85 for feeding the total milk herd, which includes the NMH, indigenous cows, and local or unimproved buffalo. Therefore, 93 percent of the concentrates are to be fed to the entire population of animals, leaving a 7 percent surplus for export. Chatterjee, however, notes that there may be considerable scope for reducing the concentrate ration currently fed to crossbreds.[15]

S. Singh contends that the introduction of crossbred cattle under the strategy of Operation Flood II will increase the feed shortage. He argues that the feed requirements of these cattle are much higher than assumed by NDDB and contain a higher proportion of concentrates and green fodder. This, he contends, will exacerbate the feed scarcity, since "green revolution" crop technology and the modest area of land devoted to fodder crops tend to depress rather than increase supplies of green fodder and concentrates. The shortage of feed and fodder, he claims, will lead to lower feed levels and thus lower productivity, necessitating the rearing of more milk animals, which will lead to even lower feed levels.[16] (While Singh's predictions do not appear to have yet taken place, the introduction of crossbred cattle has also not occurred to the extent he assumed in his arguments.) To avoid this "vicious circle," Singh states that the elimination of low productivity stock is inevitable. However, he and George also claim that the high cost of purchasing and rearing crossbreds and the shortage of feed harm small and marginal farmers who are unable to expand fodder production by diversifying their cropping patterns because of the subsistence nature of their household economies.[17] Such farmers are further constrained by the high cost of feed mixes and supply uncertainties caused by the absence of developed markets in rural areas.[18] The NDDB suggests that grazing will meet most of the feed requirements of crossbred cattle, but Singh argues that this will not satisfy their inherent biological needs and will lead to a decline in productivity.[19] Nair and Jackson also challenge the NDDB assumption that the feed constraint can be eased by a shift of cultivated land from food and cash crops to fodder.[20] They point out that there has been no change in the area devoted to fodder in India during the past 30 years. Another commentator notes that increasing feed, and especially fodder, inputs in dairying is likely to seriously increase the competition for feed among different types of livestock.[21] The Jha Report emphasizes the importance of a concerted effort to increase fodder availability.[22]

Increased supplies of fodder are, it seems, simply assumed and have not been justified by showing that feasible technological breakthroughs or changes in relative prices (which would also have an impact on the profitability of milk and foodgrain production) are imminent. Feed availability over and above the widespread increase in crop residues may also be increased through technological change that increases the production of coarse grains or by increased plantings of fodder-producing trees. There are signs that both of these changes are possible, although the potential effect on feed availability has not yet been documented. This observation is echoed by Dorsten who, having reviewed some of the literature, concludes "...the overall scarcity of feeds and fodder, ...has not been effectively tackled by the Operation Flood strategists."[23]

Halse has, however, made an attempt.[24] Using a static and mainly descriptive energy conversion "model" of Indian agriculture, he argues that the modernization of the dairy system in India through the NMH can be achieved without disrupting the nation's overall goals for agricul-

tural output, income distribution, and nutrition. He specifically attempts to demonstrate that the increased demand for animal feedstuffs can be comfortably accommodated within the overall agricultural production system. It is beyond the scope of this paper to evaluate this work in detail or to examine either past or future trends in the supply of different fodders and feeds in India. It is noted, however, that the predictions of a severe feed shortage made by S. Singh and by Nair and Jackson have not yet materialized. Neither have the Operation Flood assumptions about stocking rates and concentrate use been realized.[25] Nevertheless, it seems clear that the adoption of the stocking pattern advocated by the NDDB will put pressure on the supply of inputs. This could, especially in the short run, translate into upward pressure on prices and pressure to reduce oilseed exports or to import feedgrains. There has, however, been relatively little analysis of the effects of such market changes.

Although the importance of the interstate trade in oilseeds to the feed industries of Gujarat and Kerala is acknowledged in the literature, the effects and feasibility of international trade have not been explored.[26] Similarly, there is little analysis of the role of price policy in stimulating feed production and dairy development. For the most part, discussions of the Operation Flood strategy and anticipated feed constraints are conducted within a fixed price, constant production trend framework.

Similarly, linear-programming models reveal that green fodder may be a binding constraint at the farm level, but this constraint is not shadow priced.[27] Patel, in discussing the limitations of these models for the analysis of dairying, comments that this is also true of other constraints such as labor and credit.[28] Such models, then, although used to explore the role of livestock in farming systems, have been underutilized for studying macro-issues and formulating policy.

BREEDING AND THE NATIONAL MILK HERD

Several studies suggest that the introduction of crossbred cows and improved buffalo will increase the productivity and the profitability of dairying. As observed in one study of agricultural credit for dairying, the promotion of dairy enterprises without an increased supply of superior breeds may result in higher stock acquisition costs and thus in reduced profitability of milk production.[29] Although there is some dissent, it is generally observed that the lower age of first lactation, shorter intercalving intervals, and higher yields lower the unit costs of milk production from crossbred cattle.[30] Accordingly, Operation Flood allocates substantial resources to artificial insemination services so that farmers can have their local breeds fertilized with sperm from exotic bulls.

According to Rajapurohit, crossbreeding programs in areas where traditional cattle breeds are maintained for draft power are likely to

meet with resistance from farmers, who fear that artificial insemination will reduce the draft power efficiency of these animals. Male crossbred calves are sold off at cattle fairs and do not fetch remunerative prices because they are considered to be inferior to indigenous bullocks as draft animals.[31] Acharya, however, claims that the majority of the important draft breeds are not involved in crossbreeding programs, and those that are involved are generally of small size.[32] As a result of crossbreeding, he argues, such animals will not only increase their milk production but also their body size, and this tends to improve their draft ability. Nair counters that even if this is correct, such crossbred animals incur greater feeding costs than traditional bullocks and thus increase costs per unit of draft power provided.[33] He thus concludes that in areas where draft animals are a major source of motive power for agriculture, farmers will be unwilling to accept crossbreds. This leads Rajapurohit to recommend the introduction of crossbred cattle only in selected agroclimatic zones where nondescript breeds of cattle are neither high-yielding nor draft-efficient. He maintains that the reluctance of farmers to use exotic semen for their cattle has led to underutilization of artificial insemination services and has increased overhead costs. The difficulty of operating effective and efficient artificial insemination services is noted by Sivaraman.[34] Low success rates are reported in the Jha Report.[35] Thus, the per animal cost of artificial insemination has risen sharply.[36] The NDDB recognizes these difficulties and discusses possible solutions.[37]

According to the NDDB, a milk cow's true potential is the result of the interaction of its growth rate, size, reproduction efficiency, production level, and length of productive life. Operation Flood seeks to optimize this potential through genetic improvement.[38] The growth rate of crossbred animals is determined by successful calf-rearing practices, which include proper nutritional care and management. Farmers rarely feed young stock with relatively costly feed mixes because they perceive no immediate returns from investments in calf-rearing. The NDDB maintains that this is a false economy and, combined with the widespread lack of scientific knowledge about calf-rearing, inhibits satisfactory growth in such calves.

Milk is an important ingredient in the diet of first-generation crossbred cattle for the first 6-40 days of life. During this time such calves should receive about 100 liters of milk. This amount may exceed the milk output of local cows. Such inadequate milk production is a constraint to calf-rearing, particularly for poor milk producers,[39] and leads to high crossbred calf mortality.[40] The NDDB suggests that replacers be introduced to overcome this problem. Production and marketing of such milk replacers has not yet begun on an appreciable scale in India.[41]

The reproductive efficiency of crossbreds is a major problem for the dairy industry, according to the NDDB, which attributes this problem to ecological causes and the lack of trained manpower to provide

advice to farmers rather than to inherent genetic deficiencies. The NDDB contends that higher energy feeding, which hastens the age of maturity and ensures earlier setting in of the sexual cycle, will help to reduce this problem. The calving interval can be reduced by the successful conduct of artificial insemination.[42]

A comparative lack of adaptability to tropical climates has been the main factor limiting the introduction of western breeds into India.[43] In this respect, indigenous breeds surpass most others because they have, over the centuries, built up several important qualities--disease resistance, heat tolerance, a lower metabolic rate under given conditions of temperature and feeding, a higher digestibility coefficient, and a more efficient feed conversion ability. The NDDB seeks to overcome the environmental constraint by the introduction of crossbreds. According to the studies reviewed of NDDB mortality rates, the incidence of premature and still births and the frequency of abortions are lower in crossbreds, although the incidence of various diseases is higher. Their age at sexual maturity and the calving interval are also lower than in local cattle. The NDDB concludes that optimal performance in the NMH could be achieved by a properly designed mating system between exotic and indigenous breeds that will generate a foundation population with a preidentified exotic inheritance of between 50 and 74 percent. Hence, stabilization of the foundation population is being sought through generations of inter se mating.[44]

CAPITAL FOR DAIRY DEVELOPMENT

Apte claims that much of the capital required for Operation Flood comes from the state or central governments, who in turn receive substantial foreign aid.[45] Between 1970 and 1981, Operation Flood I received Rs 1.5 billion of aid, 80 percent of which was generated by sales of WFP/EEC dairy products.[46] Similarly, Operation Flood II received Rs 3.3 billion of foreign aid.[47]

Relatively little of the capital required for dairy development is used for breeding and other services that have a high ratio of labor to capital. But there is evidence that these services, designed to stimulate production, have been relatively underfunded.[48] Most of the capital is used for chilling plants, dairies, and feed mills. Some claim that this expensive equipment is frequently underutilized, sometimes by more than 50 percent.[49] The critics, however, are not well informed on this point and often fail to distinguish slack-season utilization from annual utilization rates. Evidence shows that satisfactory annual levels of utilization for all plants except feed mills are usually achieved, although there is wide variation between states. The worst performers have been those states and municipalities that offer low producer prices--North Bengal, Haryana, Bihar, Uttar Pradesh, and Delhi.[50] This underutilization has in the past been attributed by some to competition in procurement from private traders and to mismanagement, mishandling, and overexpenditure by cooperative institu-

tions.[51] The consequent increase in overhead costs would then further constrain the ability of the dairy cooperative institutions to generate capital internally. Although this may be so, the Jha Report also points to poor marketing of cattle feeds, the debts and losses that dairy federations inherited from prior operations as part of their terms of incorporation, political pressures to install more capacity than warranted by milk procurement, and inappropriate milk-pricing policies.[52]

What is clear, however, is that these problems, together with low producer prices and consumer subsidies, make it difficult for some state cooperative institutions to service their debts to the Indian Dairy Corporation (IDC) and this constrains the IDC in financing new capital investments or increases in working capital. This is, to some degree, exaggerated by the actions of the IDC itself, which sells donated milk commodities to dairies for recombination at prices 10 percent below the comparable domestic cost of production. Apart from distorting the milk market, such subsidies also reduce the capital sums IDC realizes from the sale of food aid.[53]

IDC finances dairy development in the states through a mixture of grant and loan funds that have about a 50:50 ratio.[54] Naturally, the states would like to see the proportion of grant funds increased, but the IDC has a statutory obligation to be self-financing, and indeed that is an objective for the whole of Operation Flood. The extent to which this can be achieved is unknown. The interest rates charged to IDC by the Government of India for loan funds and those charged by IDC to the state federations seem to be below current market rates. Whether this is a recognition of the developmental role of Operation Flood or a reflection of an inability to raise commercial money is unclear. Jul, however, claims that IDC expects to achieve financial self-sufficiency by 1990.[55]

At the village level, dairy cooperative societies are not in a position to be self-financing. Apte claims that only 10-20 percent of the total capital outlay comes from share capital and the deposits of members.[56] The balance is made up by grant funds originating in the IDC.[57] Beyond this, despite the collective nature of the movement, the unions also seem to be unable to finance their activities. This appears to be partly a result of the problems noted above, higher than planned transport costs (a result of low milk volumes in remote areas), and the general reluctance of federations (influenced by state governments) to impose user fees (or adequate fees) for those services such as artificial insemination that could bear them.[58] Federations do not seem to distinguish between such services and those of a more public-good nature and hence fail to recover costs even where that is feasible. The overriding problem, however, is a failure to fully cost all services, including marketing, which results in setting consumer prices at levels that are too low.

Some critics also argue that there are capital constraint problems at the farm level that are caused by Operation Flood. Such critics claim that Operation Flood has failed to ensure that an adequate supply of credit is available to producers and would-be producers to finance their dairy enterprises.[59] Operation Flood has no provision to assist in such financing. There are many other welfare and credit schemes that can fulfill this role, but these have not always operated adequately. There is also a shortage of good-quality cows.[60]

NOTES

[1]National Dairy Development Board, Breeding and Feeding for Milk Production in Operation Flood II (Anand, India: NDDB, 1980).

[2]K. T. Achaya and Vinod K. Huria, "Rural Poverty and Operation Flood," Economic and Political Weekly (September 1986): 1651-1656.

[3]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[4]A. R. Rajapurohit, "Cross Breeding of Indian Cattle: An Evaluation," Economic and Political Weekly (March 1979): A9-24.

[5]P. John, Economics of Dairy Development in India (Digha Chat, Patna, India: Prabhat Prakashan, 1975).

[6]The 1972 livestock census indicates that female buffalo comprised 78 percent of the adult buffalo population, while cows constituted only 43 percent of the adult cattle population. Although the ratio of breeding cattle to buffalo was 1.92 in that year--reflecting a decline over the previous two decades--buffalo are more often in milk and have higher yields. Consequently, more buffalo milk is produced than cow milk (Rajapurohit, "Cross Breeding of Indian Cattle"; see also A. Vaidyanathan, "Aspects of India's Bovine Economy: Some Preliminary Results," Indian Journal of Agricultural Economics 33 [No. 1, January-March 1978]: 1-30). Livestock census data for 1977 confirm this figure and show that the ratio of breeding cattle to buffalo had declined further to 1:74 (D. Sundaresan, "Buffalo: India's Milk Machine," in Dairy India 1985, ed. P. R. Gupta [New Delhi: Rekha Printers, 1985]).

[7]Singh, "Operation Flood II: Some Constraints and Implications"; K. N. Nair and M. G. Jackson, "Alternatives to Operation Flood II Strategy," Economic and Political Weekly (December 1981): 2129-2132; and Vinod K. Huria and K. T. Achaya, "Dairy Development in India: Some Critical Issues," Economic and Political Weekly (November 1980): 1931-1942.

[8]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[9]Tushaar Shah, A. K. Tripathi, and Maulik Desai, "Impact of Increased Dairy Productivity on Farmers' Use of Feedstuffs," Economic and Political Weekly (August 1980): 1407-1412.

[10]National Dairy Development Board, Breeding and Feeding.

[11]Ibid.

[12]Shah et al., "Impact of Increased Dairy Productivity."

[13]National Dairy Development Board, Breeding and Feeding.

[14]Nair and Jackson, "Alternatives to Operation Flood II Strategy."

[15]Chatterjee, Aid, Trade, and Rural Development.

[16]Singh, "Operation Flood II: Some Constraints and Implications."

[17]Singh, "Operation Flood II: Some Constraints and Implications"; and George, "Operation Flood and Rural India."

[18]George, "Operation Flood and Rural India."

[19]National Dairy Development Board, Breeding and Feeding.

[20]Nair and Jackson, "Alternatives to Operation Flood II Strategy."

[21]van Dorsten, Rural Impact of Operation Flood.

[22]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[23]van Dorsten, Rural Impact of Operation Flood, p. 60.

[24]Halse, "Producing an Adequate National Diet in India."

[25]Singh, Operation Flood II: Some Constraints and Implications;" and Nair and Jackson, "Alternatives to Operation Flood II Strategy."

[26]Surendar Singh and Kamaljit Singh, "Import of Donated Commodities, Export of Feed; and New Technology of Milk Production," Economic and Political Weekly (July 1985): 1227-1235.

[27]R. C. Verma and D. C. Pant, "Potentialities of Increasing Farmer Income and Employment Through Dairying," Indian Journal of Agricultural Economics 33 (No. 3, July-September 1978): 83-93; and R. N. Pandey and T. S. Bhogal, "Prospects of Increasing Income and Employment on Mixed Farms," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 141-154.

[28]R. K. Patel, "Rapporteur's Report on Economics of Livestock Enterprises with Special Reference to its Employment Potential," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 174-190.

[29]National Bank for Agriculture and Rural Development, Dairy Development Schemes in Western Uttar Pradesh (An Ex-Post Evaluation Study) (Bombay: NABARD, Economic Analysis and Publications Department, 1982).

[30]K. Narayanan Nair, "Technological Change in Milk Production: A Review of Some Critical Issues with Reference to South Asia," Economic and Political Weekly (March 1982): A15-20; and Patel and Pandey, Economic Impact of Kaira District Cooperative Milk Producers Union.

[31]Rajapurohit, "Cross Breeding of Indian Cattle."

[32]R. M. Acharya, "Strategy for Breeding Dairy Cattle in India for Enhanced Milk Production," Indian Dairyman 31 (No. 9, 1979): 607.

[33]Nair, "Technological Change in Milk Production."

[34]B. Sivaraman, "Cross-Breeding in Cattle," paper presented at national conference on crossbreeding, National Dairy Development Board, Anand, India, 1978.

[35]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[36]Rajapurohit, "Cross Breeding of Indian Cattle."

[37]National Dairy Development Board, Breeding and Feeding.

[38]Ibid.

[39]Ibid.

[40]T. N. Vaishnav, "Cross-Breeding Program in Cattle--Limitations in DDAP and Tribal Areas," paper presented at national conference on crossbreeding, National Dairy Development Board, Anand, India, 1978.

[41]National Dairy Development Board, Breeding and Feeding.

[42]Ibid.

[43]Ibid.

[44]Ibid.

[45]Apte, "Role of Cooperative Dairy Development Schemes."

[46]Lipton, "Indian Agricultural Development and African Food Strategies."

[47]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[48]Ibid.

[49]Apte, "Role of Cooperative Dairy Development Schemes."

[50]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II; and Indian Dairy Corporation, Fifteenth Annual Report 1984-85.

[51]See, for example, J. S. Garg and V. Prasad, "An Economic Investigation into the Problems of Cooperative Milk Board, Kanpur," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 143.

[52]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[53]Ibid.

[54]Ibid.

[55]Jul, "Comments on Operation Flood, 1985."

[56]Apte, "Role of Cooperative Dairy Development Schemes."

[57]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[58]Ibid.

[59]George, "Faulty Lactometers--I."

[60]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

4. EVIDENCE OF THE EFFECTS OF OPERATION FLOOD ON MILK PRODUCTION

Provided it is superior to any existing system, a new milk marketing outlet at the village level, created as a result of a dairy development project, will result in an increase in the quantity of milk marketed when it is linked to a large and unsatisfied demand for milk in urban centers. A point central to understanding the effects of dairy development projects is whether any increase in the marketed surplus of milk originates in reduced consumption, increased production, or both. Some critics claim that the effect on production is minuscule and, consequently, the increase in the quantity of milk marketed is the result of a downward adjustment in milk consumption. Such transfers of milk to other consumers may, however, result in a net welfare gain for society if farm sales are competitive and voluntary. It is possible that by substituting other consumption items for milk, the welfare of producing households may, in a revealed preference sense, increase. Despite this possibility, dairy development projects, from a public policy point of view, are considered to be instruments designed to increase milk production in rural areas and are not viewed simply as milk marketing institutions. This chapter examines available evidence on the effect of dairy development projects on milk production.

EXPECTED CHANGES FROM DAIRY DEVELOPMENT PROJECTS

The traditional farming system in India emphasizes crop (mainly grain) production, while dairying is considered to be an auxiliary source of income and employment. Cow milk is considered by many farmers to be a by-product in the production of bullocks for draft power, an indispensable input in crop production. Hence, cows are primarily maintained for their progeny.[1] When dairying is included in the traditional farm activity mix, the milk animal stock consists mainly of buffalo because of their higher milk yields and the higher fat content of their milk. This feature of the herd is reinforced by the widespread practice of determining the price of milk on the basis of its fat content.

The traditional milk marketing system relies on private traders who collect milk in rural areas and transport and sell it to nearby urban consumers. The village markets are uncertain and depend on the traders' decisions about when to collect milk. Prices may also fluctuate considerably since milk production is highly seasonal. Moreover, there is evidence suggesting that traders do not collect milk during the dry season in a village if they consider the volume to be inade-

quate.[2] Additionally, when the number of traders is small, there is always the risk of the traders operating collusively. Producers may, however, market surplus milk in the form of milk products such as ghee.

Indian dairy development projects make two purposeful interventions within the traditional milk production and marketing system. First, they establish milk marketing outlets at the village level, managed by a producers' cooperative, to collect milk at a predetermined and published price throughout the year. Second, the village cooperative is designated as the distribution center for inputs, artificial insemination services, and technical knowledge to help farmers increase milk production. The objectives and services of these primary, village cooperative societies are well described by Gupta.[3] Through these means the projects are expected to reduce the uncertainty inherent in the traditional way of marketing milk and to induce farmers to invest in building up milk production assets. Farmers are also expected to increase the productivity of their existing assets by utilizing the inputs (feedstuffs, artificial insemination, and technical knowledge) provided by the projects through the dairy cooperative societies. Hence, the projects hope to establish a new and higher equilibrium level of output.

The expected changes in the structure of milk supply may also have an effect on crop production at the farm level. Farmers may respond to the introduction of the project by reducing the resources devoted to crop production in order to make them available to their dairy enterprise. This response may take the form of the diversion of land and labor resources from grain crops to fodder production and, as a consequence, result in reduced crop output. On the other hand, the introduction of modern systems of milk production and the increases in income expected to result, together with more stable receipts from milk sales, may encourage farmers to spend additional resources on crop inputs, such as fertilizer, that would increase the productivity of factors devoted to crop production.

A majority of the studies concerning the farm-level impact of dairy development refer to hypotheses tested with sets of data drawn from specific regions of India. These studies, grouped according to the operational hypothesis that is tested, are reviewed below. First, however, to establish a base line for comparison, an examination is made of the literature concerning general trends in the dairy sector in the absence of the projects.

TRENDS IN DAIRY DEVELOPMENT

A study of the Punjab by Grewal and Rangi provides historical background on the development of the dairy sector for the period 1961-1978.[4] Punjab in that period experienced a major revolution in grain production and became the most agriculturally advanced state in India. The authors suggest that the level of development of Punjab's dairy

sector probably represents the short-run upper bound to dairy development in India without the incremental investment envisaged under the projects that collectively form Operation Flood.

The authors claim that the productivity of milk animals in the Punjab was stagnant in the period 1970-71 to 1977-78. Buffalo milk yields were 4.31 liters per day at the beginning of the period and 4.22 liters per day at the end. Cow yields also remained roughly constant at a little over 3.0 liters per day. The authors compare the stagnant productivity in milk production with the substantial increase in productivity in crop production, where "average yields of wheat and paddy increased from 2,238 and 1,765 kg per hectare in 1970-71 to 2,537 and 2,910 kg per hectare, respectively, in 1977-78."[5] The authors claim that, in the case of the Punjab, these increases can be attributed to the advent of improved technology (green revolution) and the increased use of inputs. They point out that there were no comparable changes in the dairy sector.

Total milk output, however, increased in the Punjab from 2.1 million tons in 1970-71 to 2.9 million tons in 1978-79.[6] In the absence of increases in productivity the authors attribute the increased production to an increase in milk animals. They show that there were 47,000 crossbred cows in the Punjab in 1978, which was about 1.5 percent of the combined population of milk cows and buffalo. Therefore, even if the number of crossbred cows had been growing rapidly prior to 1978, the number in that year is too small to justify the increase in milk output. However, the buffalo population almost doubled between 1961 and 1978, while the number of local cows dropped sharply. It seems, therefore, that it was the growth of the buffalo population that led to the increase in milk output. Kataria observes similar trends in Haryana over the period 1956-77.[7] Grewal and Rangi offer the following explanation for such changes in the composition of the milk herd in Punjab: "...the important reasons for the decline in the population of cows are increased mechanization of agriculture in which the demand for draft cattle has declined specifically and also replacement of low-yielding indigenous cows with buffaloes and crossbred cows...," while Nair, writing about Kerala, also points to a decline in the demand for draft animals.[8]

Recent evidence for all India in Nair provides generalized support for the arguments made by Grewal and Rangi. Specifically, Nair points out that the all-India ratio of female buffalo to cows rose steadily throughout the period 1961-77. Nair also attributes this trend to the feed conversion-efficiency of Indian buffalo and to the increased availability of crop residues as a result of the spread of green revolution technology.[9]

Shah, accepting that increased milk production is related to structural change in the composition of the milk herd, seeks evidence from Gujarat.[10] Using only livestock census data for Gujarat from 1961 and 1977, he examines the hypothesis that investment in dairy develop-

ment increases the percentage of milk animals in the total bovine population. These data suggest that structural changes in the herd are more pronounced in districts where dairy development has been most intensive than in the rest of Gujarat. Similar results using farm-level evidence from Gujarat were obtained by Vyas and Choudhary.[11] Cause and effect, however, have not been established.

EFFECTS ON PRODUCTION

In the existing empirical evidence on the effect of specific dairy development projects, there are no longitudinal studies that separate specific project effects from secular trends. There are, however, several studies that assess project effect at the farm level by using a two-group comparison--a group of farms that were exposed to the project and a group that were not.

Quasi-experimental Design Studies

The simple quasi-experimental design is one of the analytical approaches used to evaluate the effects of dairy development projects. This method is used extensively in the social sciences and in the field of agricultural development.[12] The method does not attempt to assign causality to observed differences. Instead the approach assumes the existence of a modus operandi that is used to guide the interpretation of results.[13]

This method has been used in the evaluation of dairy development projects in the following way. Within a selected milkshed, a detailed census of the villages is taken, covering agricultural, technical, distributional, and other socioeconomic characteristics of the farm households. Then a sample is selected of one or more villages that have participated in the project. Similarly, a sample of one or more villages is selected from those villages that have not participated in the project but that resemble the subject villages in their socioeconomic and agroclimatic conditions. A set of indicator variables is selected and evaluated for both subsamples. Differences in the indicator variables are attributed to characteristics that are different in the two groups--namely, participation in the project. The crucial decisions to be made in implementing this method are the choice of the sample to ensure representativeness of the population under study, the choice of the control group to ensure similarity with the subject group, the choice of the procedure for data collection, and the choice of analytical method.

Several studies have followed this methodology.[14] The study by the Institute of Rural Management, Anand (IRMA) is representative. This study was conducted in three states--Rajasthan, Tamil Nadu, and Gujarat. Within the districts selected for study, a subject village with a dairy cooperative society (DCS) was chosen and care was taken to

ensure that the village was representative of the DCS villages of the area. Since data prior to the establishment of the DCS was not available for the DCS village, another village without a milk cooperative but resembling the selected DCS village in most other respects was selected as a control.

The data selection started with a general census of all the households of the selected villages, which collected information on household composition, ownership of land, livestock and other assets, and production and disposal of milk. A more detailed survey followed for a sample of households. The sample was selected so that households with and without land, with and without milk animals, and with small and large holdings of land and animals were adequately represented. The investigation was conducted in four rounds and covered aspects such as land use, cultivation practices, use of inputs, production and disposal of crops, cattle use and feeding practices, production and disposal of milk and milk products, household expenditure patterns and changes in assets, food consumption patterns, membership in organizations, and views on their functioning. The investigators used semistructured questionnaires.

The indicators for project effects included land and milk animals owned, milk production and its distribution over various household classes, milk disposal, incomes, share of milk revenues in incomes, availability of milk and milk products to producer households, and cost of milk produced. The indicators of consumption effects included per capita consumption by socioeconomic group of various food items per day, including milk and milk products. Nutrition indicators were not obtained from the consumption data.

The following results were reported: the average number of milk animals per household was higher in the DCS village in one out of the three cases studied; milk yield per animal in milk was higher in the DCS villages in all three cases and ranged from 12 to 58 percent; the proportion of animals in milk to total milk animals was higher in the DCS villages; milk production per household was 50-100 percent higher in the DCS villages; and the marketed surplus was higher in the DCS villages. The reported differences are all in favor of the DCS villages.[15] These conclusions were reached, however, on the basis of simple comparisons of group averages without statistical testing of differences in means. The results are, at best, only indicative. Without more rigorous analysis, it is not possible to directly assign all or any of the observed differences to the operation of the projects, since no effort was made to control for any differences in village or household characteristics or differences in preproject (initial) conditions. (In general, the control of such differences is possible only if some form of multivariate analysis is used, since it is impossible to select samples that are identical in all respects.)

Shah, using the same data, proposes a "four-stage dairy development framework" induced by the dairy development projects.[16] His Stage

I corresponds to a farming system where milk has limited economic value as a by-product of draft power. In Stage II, milk obtains an economic value as a result of better feeding of milk animals, and buffalo emerge as the main milk animal. In Stage III, increasing mechanization reduces demand for draught animals and leads to a higher proportion of milk animals in the bovine population. In Stage IV, crossbred technology is widely adopted. Shah employs this framework using the village averages derived from the IRMA study.[17] Despite the attractiveness of the framework, formal statistical testing was not attempted, as degrees of freedom were inadequate. Hence, Shah's results are also indicative and typological, but not definitive.

In an earlier study, but using the same approach as the IRMA study, Thakur found the project group in Gujarat to have a higher production of milk per milk animal, a higher marketed surplus of milk, a higher use of improved agriculture inputs, and higher incomes from both crops and dairying.[18] Thakur points to the provision of a package of technical inputs as an important determinant of the increase in milk supply and the higher crop incomes in the subject group. He also argues that there are other technological spin-offs of dairy development in crop production, since a farmer who has been educated to appreciate the importance of improved inputs in milk production is likely to seek and apply new knowledge to crop production as well. Thakur claims that the introduction of new seeds for fodder crops induces farmers to seek improved cultivation techniques and to adopt or increase use of fertilizers, high-yielding varieties, and better water-management techniques. He also claims that farmers are likely to become more receptive to extension advice when they participate in a dairy program. Sidhu, however, in commenting on this and other studies, concludes "... the techniques [used] to measure the impact of dairy development projects on the adoption of improved agricultural inputs and total incomes may be questionable...."[19] The study by Bowonder et al. shows higher milk yields in five cooperatives when matched with nearby villages in Andhra Pradesh, Karnataka, and Maharashtra. The matching, however, is basically geographical; other characteristics differ greatly. One village with 10 milk cattle is paired with a village with a single cow in milk. Three of the cooperatives that received government loans for acquiring cattle were matched with villages that did not receive loans. Conversely, one village with loans was matched with a cooperative with no loan program (the loan programs were independent of the cooperatives in all cases). Producers in the cooperative villages, however, still had higher yields. In short, the studies by Thakur and Bowonder et al. have the same problems as the IRMA study. Although the indicators show differences in favor of the project groups, the project and control groups are not strictly comparable, and at least some of the differences may be attributed to other village and household characteristics. George, who is severely critical of such studies, emphasizes the problems of representativeness and comparability of control and subject groups in these studies but offers little in the way of methodological or analytical improvements.[20]

Milk Production Technology Studies

Although there are no satisfactory studies that use rigorous analysis to separate the effect of dairy development projects from the effects of other factors, a separate body of research has used econometric and other techniques to assess the actual or potential effect on milk output of the introduction of crossbred cows and changes in numbers of milk animals, and the effect on productivity of better feeding.

The introduction of crossbred milk animals has been slow and its effectiveness highly debated.[21] None of the existing studies addresses the question of adoption of crossbreds (new technology) directly. They deal mostly with the measurement of productivity differences. Table 2 shows the average productivity differences among milk animals on two agricultural university farms in Maharashtra. Farm 2 shows much smaller differences in productivity than Farm 1.

Table 2--Comparative productivity of milk animals on two agricultural university farms

Type of Animal	Liters per Lactation[a]	Liters per Day	Days per Lactation[b]
Farm 1			
Crossbred cows	2,609	8.60	303
Buffalo	1,359	4.10	331
Local cows	604	2.30	263
Farm 2			
Crossbred cows	1,212	4.00	303
Buffalo (Surti)	1,175	4.29	274
Buffalo (Murah)	938	4.06	231
Saniwal cows	866	3.67	236

Sources: K. T. Achaya and T. G. Pawar, "The Economics of Milk Production by Different Types of Milch Animals," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 153; and S. P. Kalyankar, "Economics of Milk Production by Different Breeds of Cows and Buffaloes," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 155.

[a] Not reported in Kalyankar (Farm 2); computed as liters per day times days per lactation.

[b] Not reported in Achaya and Pawar (Farm 1); computed as liters per lactation divided by liters per day.

The differences in yields of crossbred cows between the two studies are substantial and imply that even under experimental station conditions crossbred cows may not realize their full production potential (the bovine equivalent of the well-known "yield gap" from the green revolution literature). The second study indicates that buffalo may be almost as good milk animals as crossbred cows. Yet Rajapurohit, citing unpublished evidence drawn from military farms, claims that crossbreds are clearly superior to buffalo.[22] In contrast, and taking into account that buffalo milk has a higher fat content--a characteristic highly appreciated by consumers--Kalyankar's data suggest that buffalo may be superior to the crossbred cow. Detailed evidence on the value and productivity of buffalo in India is provided by Sundaresan.[23] All of these studies, however, show that both crossbred cows and buffalo are markedly superior to local cows. It is commonly accepted in India that crossbred cows are about twice as productive as local cows.[24]

Presuming such productivity differences between local and crossbred cows, some studies have attempted to decompose these differences into the shares attributable to genetic superiority and the increased use of feedstuffs. Sankhayan and Joshi use village data (villages selected randomly) from the Punjab and a production function with a dummy variable specification for genetic differences to examine the differences in yields between crossbred and local cows.[25] They find that the yield of crossbreds is about twice as high as the yield of local cows and is entirely accounted for by greater feed consumption. Similar evidence is presented by Gangadharan.[26] A study by Kumar and Singh, however, attributes the difference about equally to higher levels of feeding and genetic superiority.[27]

If crossbred cows are superior milk producers, it is important to know why their adoption has not been widespread. Their poor acceptance is popularly attributed to restricted fodder supplies, a perception that crossbred bullocks are poor draft animals,[28] a lack of knowledge among farmers (especially the poorer ones),[29] and the limited resources available to small farmers.[30] The need for increased fodder supplies is supported by the evidence that crossbred cows require substantially higher feed inputs than local cows. However, crossbreds are more efficient feed converters than local cattle.[31] The claim that technical knowledge is not well diffused may be related to the scale and efficiency of knowledge dissemination (extension) procedures. The adequacy of farm-level resources for adopting crossbred technology may be related to issues of risk. Neither of these matters has been examined at all in the literature.[32] However, some partial evidence on calf mortality is provided by Raut et al. using data from West Bengal.[33] In a sample of 384 households from 79 villages in 1977/78, they observed the following mortality figures among crossbred and indigenous calves:

Type of Animal	Mortality Rate (percent)	
	Male Calves	Female Calves
Local cows	14.6	17.9
Crossbred cows	38.0	18.2

Their figures suggest that there is no appreciable difference in mortality between female calves but there is a substantial difference in mortality rates among male calves. Rajapurohit attributes this mainly to farmer behavior rather than environmental conditions or an inherently high level of mortality. This evidence is consistent with the belief among farmers that crossbred bullocks are not acceptable as draft animals.[34]

Increasing the proportion of milk animals in the bovine population is one way in which dairy development projects might increase milk output. The projects of Operation Flood have been designed on the premise that milk output will increase through raising productivity and upgrading the local cattle population rather than from a direct increase in milk animal numbers. It is possible, however, that milk animal numbers may rise. The empirical evidence available to the authors does not include any study of project effect on milk animal numbers, although Nair, arguing from an all-India perspective, implies that any effect under Operation Flood I must have been small, since less than 3 percent of the milk animal herd was covered under the program.[35] Evidence from the studies by IRMA and Shah is not conclusive, since the quasi-experimental designs used in these studies preclude the attribution of causality.[36] Moreover, there are no studies that rigorously examine the factors that lead to the apparently exogenous changes observed in the composition of the milk herd (for example, the trend to buffalo in the Punjab).

Better feeding is extensively documented as a major source of increase in the productivity of milk animals. As early as 1964 it was pointed out that an increase in the feeding of concentrates may, initially, result in a more than proportionate increase in milk output.[37] There are claims that better feeding alone can increase milk yields by 50 percent: "...the available experimental evidence, meager as it is, shows that better feeding can increase the average yield of animals by 50 percent or more...."[38] Even though this claim refers to experimental conditions, in principle such a relationship is expected to hold in farm conditions, although the magnitude of the difference may be smaller.[39] A study by Sankhayan and Joshi, using a Cobb-Douglas milk production function and field data from the Punjab, shows that feeding of concentrates is the most important determinant of increased milk yields.[40] Similar results also using a Cobb-Douglas function were obtained for Haryana cows by Kumar, Patel, and Raut.[41] B. Singh, using different data from the Punjab, supports this finding.[42] Conversely, Kumar and Singh, using feeds measured in nutrient terms, find that

digestible nonnitrogenous nutrient input is more important than the crude protein input in milk yields.[43] This is exactly opposite to the prevailing view, which considers concentrates to be of special significance for milk production.[44]

A number of studies attempt a dynamic specification for feed-milk relationships based on the view that the effect of feed is distributed over the length of the lactation period, and assume that the milk yield potential at a particular stage of lactation depends on feed inputs in current as well as past lactations.[45] These studies formulate dynamic milk production functions, introduce a Koyck-distributed lag specification for the effects of feed, and decompose the effects into direct, cumulative, and carryover components. They conclude that carryover effects are significant determinants of yields. This econometric specification is not particularly convincing, however, because it mixes two distinct feed requirements of milk animals, namely, maintenance and production requirements. When maintenance is not satisfied, there is a deterioration in the production capacity of the milk animal, that is, a deterioration in the quality of the animal stock and hence a decline in the services it provides. Patel suggests that the lag structure should have been estimated instead of assumed.[46]

Overall, however, the evidence reviewed on the effect of better feeding on productivity is intuitively plausible. It suggests that better feeding not only increases yields at a given stage of lactation but also affects the production capacity of the milk animal in subsequent lactations. This seems reasonable, as better feeding should increase yields and upgrade the production capacity of the milk herd. Thus it is possible that dairy development projects, to the extent that they induce better feeding, may have a measurable effect on both milk yields and the production potential of the milk stock. However, as Dorsten has noted, a better understanding of milk supply response at the farm level is necessary if it is to be established whether Operation Flood has or has not exerted a positive influence on the production of milk.[47]

INTERACTIONS WITH CROP FARMING

It is often argued that the dairy enterprise is complementary to other farming enterprises.[48] The three main potential links of dairy development to crop farming are the potential shift of resources (labor and land) from crop production to dairy activities, the potential effect of increased receipts from milk sales on cash constraints in crop production, and the potential effect of the introduction of new concepts of dairy management on the adoption of new technology in crop production. The reverse of this last proposition is also possible but such relationships have not been studied.

Dairying may affect the labor market. John claims that labor costs amount to about 20 percent of the cost of producing milk, but

there is little evidence on this point.[49] With regard to the demand for labor, there is some empirical evidence that shows that the dairy enterprise mainly utilizes family labor. Singh et al., using data from the area of the Operational Research Project of the National Dairy Research Institute in Karnal, show the following pattern of labor use:[50]

Type of Labor	Percent of Farm Labor		
	Dairy Activity	Crop Production	Total
Family labor	29	23	52
Hired labor	10	38	48
Total	39	61	100

If the above pattern holds more generally, a higher labor demand associated with the introduction or expansion of dairying will probably be satisfied by reducing leisure (voluntarily or involuntarily) rather than by reducing labor supply to crop production. If, however, the labor supply function to dairying has a positive slope, the increased employment opportunities may have some effect on wages. Singh et al. estimate a labor demand function for dairying and conclude that total labor demand is largely determined by the number of milk animals kept.[51] If such evidence has more general validity, a large increase in the number of animals following a dairy development project will result in a large increase in the demand for labor. (This is not, however, the objective of Operation Flood.) But if the effect of dairy development projects operates mainly through productivity changes, the labor-demand link is likely to be much weaker. This question has not been widely studied, although Kumar, Patel, and Raut report that labor inputs (both family and hired) are not significant variables in explaining milk production for Haryana cows.[52] Some analysts are concerned with the indirect effects of Operation Flood on labor demand and argue, somewhat speculatively, that if crossbred technology is widely adopted, it will reduce the availability of animal draft power and thus encourage labor-displacing mechanization.[53]

Proponents of dairy development commonly stress the importance of female and child labor in dairying.[54] They speculate that an increase in the demand for labor as a result of dairy development may be answered without a severe effect on the labor supply to crop production; that is, that there is a clear sexual and age division of labor between crop and dairy activities. However, evidence on this matter is mixed. For example, in a study of landless households in Karnal district in Haryana, women and children were found to account for only 35 and 10 percent, respectively, of the labor input into dairying.[55]

The land-use link to the cropping system is expected to operate through the increased cultivation of fodder and hence the withdrawal of land from the production of grains or other foodstuffs.[56] In turn this

may affect food commodity prices. This link has not been directly explored in the literature but it does form part of the debate on the potential sources of additional feed required for the successful introduction of dairy development projects. A study by Rajapurohit looks specifically into the feed availability issue with reference to dairy development programs in Karnataka. He reports that "the cultivation of fodder grasses is quite rare except in those pockets where dairy and horse-breeding systems are located...," and that "...milk animals in many districts are fed below the subsistence level and their milk yield is low...," which leads to a vicious circle of a larger number of milk animals and a higher stocking density that feeds back into low yields. He suggests that a possible solution is the upgrading of grazing lands and the cultivation of fodder and thus implies that there is a genuine link between dairy development and crop production.[57] This link needs further examination. Similarly, by providing crop by-products, intensification of dairying may favor shifts between various cropping activities.

Arguments that point out the energy costs of dairy production, similar to the discussion of fodder availability above, are sometimes presented to demonstrate that concentration on dairy enterprises could strain India's grain supply. However, as current production of grain in India meets or exceeds demand in a normal year, a greater concern is the relatively low level of demand by the poor. If, as is often argued, dairying is an activity in which the rural poor may have a comparative advantage, profits (and hence increased income) from dairying may lead to increased demand for grain.[58] There is every indication that India's agriculture and marketing systems could respond to such an increase in demand.

NOTES

[1]V. S. Vyas and K. M. Choudhary, "Economics of Dairy Farming in Mehsana District," Artha-Vikas 7 (No. 2, July 1971): 20-40; and John, Economics of Dairy Development in India.

[2]Singh and Kelley, AMUL: An Experiment in Rural Economic Development.

[3]Gupta, Dairy India 1983.

[4]S. S. Grewal and P. S. Rangi, "Economics and Employment of Dairying in the Punjab," Indian Journal of Agricultural Economics 30 (No. 4, October-December 1980): 120-125.

[5]Ibid.

[6]Ibid.

[7]M. S. Kataria, Geography of Indian Livestock and White Revolution (Kurukshetra, India: Vishal Publications, 1982), pp. 1-104.

[8]Grewal and Rangi, "Economics and Employment of Dairying in the Punjab," p. 121; and Nair, "Technological Change in Milk Production."

[9]K. Narayanan Nair, "White Revolution in India: Facts and Issues," Economic and Political Weekly (June 1985): A89-95.

[10]Tushaar Shah, "Economic Impact of Operation Flood: Report on a Detailed Survey of Six Villages," Institute of Rural Management, Anand, India, 1983.

[11]Vyas and Choudhary, "Economics of Dairy Farming."

[12]See D. J. Casley and D. A. Lury, Monitoring and Evaluation of Agriculture and Rural Development Projects (Baltimore: Johns Hopkins University Press, 1982) for an exposition of the relevant advantages and disadvantages of this method as well as common implementation problems in rural development projects. For a more detailed but generalized treatment of this methodology, see P. H. Rossi, H. E. Freeman, and S. R. Wright, Evaluation: A Systematic Approach (Beverly Hills, Cal.: Sage Publications, 1979), especially Chapter 6.

[13]See Casley and Lury, Monitoring and Evaluation of Agriculture, for a discussion of the validity of the project modus operandi assumption.

[14]Vyas and Choudhary, "Economics of Dairy Farming"; D. S. Thakur, "Impact of Dairy Development through Milk Cooperatives: A Case Study of Gujarat," Indian Journal of Agricultural Economics 30 (No. 3, July-

September 1975): 83-96; Institute of Rural Management, "Profiles in Development"; Shah, "Economic Impact of Operation Flood"; Singh and Das, "Impact of Operation Flood I"; and B. Bowonder et al., "Impact of Dairy Development Programs," Center for Energy, Environment and Technology, Administrative Staff College of India, Hyderabad, 1985 (mimeographed).

[15]Almost identical results were obtained from farm-level surveys in Mehsana district of Gujarat during 1967 and 1968 (Vyas and Choudhary, "Economics of Dairy Farming").

[16]Shah, "Economic Impact of Operation Flood."

[17]Institute of Rural Management, "Profiles in Development."

[18]Thakur, "Impact of Dairy Development through Milk Cooperatives."

[19]D. S. Sidhu, "Rapporteur's Report on Dairy Development and the Bovine Economy," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 161-171.

[20]George, "Faulty Lactometers - I."

[21]Rajapurohit, "Cross Breeding of Indian Cattle."

[22]Ibid.

[23]There are, however, disadvantages to buffalo as dairy animals: (a) they are much heavier, thus requiring more nutrients per kilogram of fat-corrected milk than cattle of similar performance; (b) the detection of oestrus is difficult; (c) they require considerable attention during calving; and (d) they need skilled care and management for the first three months or until weaned. See D. Sundaresan, "Buffalo: India's Milk Machine," in Dairy India 1985, ed. P. R. Gupta (New Delhi: Rekha Printers, 1985).

[24]See, for example, India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[25]P. L. Sankhayan and A. S. Joshi, "Resource Productivity in Milk Production of Crossbred and Indigenous Cows in Rural Areas of Ludhiana District (Punjab)," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 105-111.

[26]T. P. Gangadharan and S. L. Kumbhave, "Rationale of Fodder Subsidy: The Case of Kollengode Dairy Economy," Indian Journal of Agricultural Economics 37 (No. 3, July-September 1982): 260-265.

[27]P. Kumar and R. P. Singh, "Dynamic Feed-Milk Relationship and Technological Change in Milk Production," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 126-132.

[28]See, for example, Nair, "Technological Change in Milk Production"; and Huria and Achaya, "Dairy Development in India."

[29]Chatterjee, Aid, Trade and Rural Development.

[30]J. S. Garg and M. P. Azad, "Economics of Crossbred Cow: A Case Study," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 149-150.

[31]A study examining the utility of a fodder subsidy scheme in Kerala (Gangadharan and Kumbhave, "Rationale of Fodder Subsidy") shows that the productivity of local cows was not responsive to increased fodder supplies.

[32]The only empirical study known to the authors that deals with risk is by D. R. Kalita and A. C. Sharma, "Potentialities of Livestock Enterprises on Unirrigated Small Farms in the Gobardhana Block of Assam," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 164, a framework that deals with the income risk of a mixed farming system. Thus, the study is not specifically focused on risk in dairy development at the farm level. Moreover, Rajapurohit, "Cross Breeding of Indian Cattle," in an extensive discussion of the crossbreeding program in India, does not address farm-level risks.

[33]K. C. Raut, Shivtar Singh, and R. L. Rustogi, "Comparative Economics of Rearing Cross-Bred and Non-Descript Calves under Village Conditions," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 139-144.

[34]Rajapurohit, "Cross Breeding of Indian Cattle."

[35]Nair, "White Revolution in India."

[36]Institute of Rural Management, "Profiles in Development"; and Shah, "Economic Impact of Operation Flood."

[37]John W. Mellor and Bruno de Ponteves, "Effect of Growth in Demand for Milk on the Demand for Concentrate Feeds in India 1951-66," Indian Journal of Agricultural Economics 19 (1964): 131-146.

[38]Parmatma Singh and Dayanatha Jha, "Economic Options in Milk Production," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 97.

[39]See Shah, "Economic Impact of Operation Flood"; and Nair, "White Revolution in India."

[40]Sankhayan and Joshi, "Resource Productivity in Milk Production."

[41]P. Kumar, R. K. Patel, and K. C. Raut, "Lactationwise Production Function and Concentration in Milk Production for Haryana Cows," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 128-133.

[42]Baldev Singh, "Economics of Milk Production and Bovine Livestock Compositions in a Growing Economy," Indian Journal of Agricultural Economics 34 (No. 2, April-June 1979): 61-70.

[43]Kumar and Singh, "Dynamic Feed-Milk Relationship and Technological Change in Milk Production."

[44]See, for example, Singh and Singh, "Import of Donated Commodities, Export of Feed."

[45]See Kumar and Singh, "Dynamic Feed-Milk Relationship and Technological Change in Milk Production."

[46]Patel, "Rapporteur's Report on Economics of Livestock Enterprises."

[47]van Dorsten, The Rural Impact of Operation Flood.

[48]A. S. Patel and N. S. Jodha, Economic Relationship Between Crop Farming and Dairying in a Developing Area: A PL-480 Micro Level Study of South Gujarat (Gujarat, India: Agroeconomic Research Center, Sardar Patel University, 1979).

[49]John, Economics of Dairy Development in India.

[50]C. B. Singh, J. P. Dhaka, and S. P. Sharma, "Labor Absorption and Factors Influencing Levels of Employment in Crop, Dairy, and Poultry Enterprises," Indian Journal of Agricultural Economics 36 (No. 4, October-December 1981): 14-20.

[51]Ibid.

[52]Kumar et al., "Lactationwise Production Function."

[53]Singh, "Economics of Milk Production."

[54]See, for example, Somjee and Somjee, "Cooperative Dairying and the Profiles of Social Change in India."

[55]Singh et al., "Labor Absorption and Factors Influencing Levels of Employment."

[56]This expectation derives mainly from normative linear programming studies (see A. Singh and R. V. Singh, "Impact of Dairy Enterprises on Productivity and Employment," Agricultural Situation in India 32 [No. 3, June 1977]: 139-142; Verna and Pant, "Potentialities of Increasing Farmer Income and Employment;" S. A. Radhakrishnan and M. Sivanandham, "Dairying as a Subsidiary Enterprise in Farms--A Micro Level Analysis," Indian Journal of Agricultural Economics 30 [No. 3, July-September 1975]: 159; A. G. Saini, "Impact of Dairy Enterprises on Farm Incomes in Punjab," Indian Journal of Agricultural Economics 30 [No. 3, July-September 1975]: 159; and A. S. Sirohi et al., "Role of Dairy-Poultry Enterprises for Increasing Income and Employment on Farms in the Union Territory of Delhi," Indian Journal of Agricultural Economics 35 [No. 4, October-December 1980]: 112-119).

[57]A. R. Rajapurohit, "Bovine Feed Availability and Requirements in Karnataka with Reference to Dairy Development Programmes," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 111-120.

[58]Mellor, The New Economics of Growth.

5. EVIDENCE OF EFFECTS ON INCOMES, INCOME DISTRIBUTION, AND NUTRITION

The effect of dairy development projects on the household incomes of milk producers depends on the additional milk output produced, the cost involved, and the extent of the interactions between the dairy enterprise and cropping activities. It is important, however, to draw a distinction between absolute and relative income changes. Although the projects intend to raise milk output, and this may have a positive effect on average incomes, these income changes may be unequally distributed. Also, taking into account the distribution of benefits among consumers, the projects may favor the richer urban and rural classes.

EFFECTS ON INCOMES

Additional milk production involves the use of additional purchased and nonpurchased inputs, such as feed and forage and investment in improving the milk stock. In addition, there may be interactions with the cropping system that affect total farm income through changes in the allocation of resources to crop and dairy activities. The income effects of dairy development have been examined in a number of studies reviewed below.

The methodology of these studies has been described in the previous section. The IRMA study examines the following indicators: quantity of milk marketed and prices received, revenue from milk and milk products, and costs of milk production.[1] The authors attribute the creation of a milk market in one of the villages, where previously there was none, to the project, even though a cooperative was not established. They also report higher milk prices for the cooperative villages in all three cases examined. Since the quantity of marketed milk is higher in villages with cooperatives than in villages without cooperatives, the revenue from milk sales is also higher in the villages with dairy cooperative societies. The authors also state that the cost of production was markedly higher in the villages with cooperatives than in the control villages in two out of the three cases examined and that this was due to the use of greater quantities of concentrates. However, the authors' conclusions can only be regarded as indicative, since the evidence is derived from a single-visit survey instead of from annualized revenue and expenditure data obtained from several visits.[2] Moreover, they do not take into account interactions with the cropping system and possible changes in the level and composition of crop output.

A study by Shah using the same data concludes that

> ...the cooperatives offer a significantly higher cash as well as real price to their member producers in addition to providing them a year-around market for milk, apart from producing powerful incentives to increase milk products without substantially increasing the "relevant cost" of production....

This implies higher incomes for producers in the project villages.[3] Thus the study provides some indications, but not proof, of a positive project effect on incomes. The same judgment also applies to the results of studies by Thakur and by Desai and Varma.[4]

Linear programming formulations are usually normative but studies based on them have been used to examine the possible effects on incomes, production, employment, and optimal cropping patterns of the introduction of a dairy enterprise into an otherwise crop-based farm production model.[5] The analytical framework of the linear programming formulation in these studies consists of maximizing a linear net-farm revenue function subject to a set of constraints relating to land, labor, capital, and fertilizer availability as well as minimum level cereal production and maximum crop area constraints.[6] The choice of such constraints, obviously, is of critical importance for the optimal solution.[7]

A number of linear programming studies report that farm income increases following the introduction of a dairy enterprise into the farm-activity mix, thus implying that milk production is profitable. This, of course, merely verifies the conclusion that can be inferred from the prevalence of dairy production nationwide. The optimal activity pattern usually shows an increase in the stock of crossbred milk animals, higher utilization of land by bringing into cultivation uncropped land, higher overall demand for labor, and higher utilization of farm family labor. (It is well known that such farm-level results may not hold when aggregated economy-wide.)

However, several methodological questions about the linear programming studies preclude definite conclusions for planning or policy purposes. The crucial elements of the linear programming method are the choice of field data to construct the input-output table and the resource and net revenue vectors, the manner in which dairying and other activities are modeled (multiperiod, integer, static, and so forth), the introduction of different technologies, the choice of constraints, the representation of built-in institutional factors such as characteristics of the labor market, and the markets for other inputs and outputs. For instance, a clear picture of the relative importance of the constraints is given by the shadow prices of the resources.[8] However, none of the studies reports these shadow prices nor do any of them attempt sensitivity analyses to show how the optimal solution responds to different resource availabilities. Moreover, as used in these studies, the shadow prices have little or no value as an ex-post evaluative method for dairy development projects. In addition, these studies address the effects of introducing a dairy enterprise for the

first time while most dairy development projects based on village cooperatives are concerned with raising output from existing dairy activity either as a sole enterprise or with other enterprises.

Farm-management studies report positive results on incomes following the introduction of dairy activity.[9] Such studies follow a costs-and-returns procedure reporting the financial costs and benefits of milk production. These studies commonly conclude that milk production is profitable and increases incomes while simultaneously reducing the seasonality of overall farm income. A note of caution on the kind of data used by these studies is given by Patel:

> A striking outcome of a careful perusal of the papers presented is a conspicuous absence of a standardized costing methodology in respect of milk production...; wide variations in milk production cost may be attributed to differences in breeds, management practices, region, seasons, and farm size and also the cost concepts employed....[10]

Despite these caveats and the weaknesses of the other studies noted above, Dorsten, who reviewed some of this literature, felt able to conclude "...that Operation Flood has had on the whole a positive impact on the incomes of rural milk producers...."[11] He notes, however, possible negative effects on the incomes of producers in the immediate hinterlands of the metropolitan areas as their quasi-monopoly position is eroded. Some observers argue that this is a generally desirable consequence.[12]

None of the evidence reviewed above, however, emphasizes that producer prices for milk are set mainly by state and municipal governments. These prices vary considerably across the nation.[13] Those paid by Delhi and Calcutta are particularly low. More importantly, the setting of producer prices does not seem to be related to production costs. Hence there may be substantial variations in the effects of dairy development on the incomes of producers. This, however, has not been studied.

DISTRIBUTION OF GAINS TO PRODUCERS

It has been shown that the distribution of bovine ownership is more even than the distribution of land ownership.[14] Thus, small and marginal farmers tend to keep more milk animals per unit of land owned than do large farmers. This points to a more even distribution, among those owning or renting land, of the output of the dairy activity than the output of the crop activities of the farm. A study by Moore indicates that despite lower output per milk animal, small farmers are more efficient milk producers than large farmers. This he attributes to a more intensive use of labor by small farmers.[15] Because of the above observations, several authors, including Jha, maintain that the

development of dairy activity has a large positive distributional effect.[16]

This effect is examined by IRMA by comparing the distribution of land and milk animals in the cooperative and the control villages and also by looking specifically at the effects on landless and marginal farmers.[17] The study finds that both milk yields and milk production are higher for landless households in the dairy cooperative society villages than in the control villages and concludes that the "...landless households in the cooperative [sic] villages in all the three districts were better off in terms of [the milk] contribution per animal in milk than their counterparts in the control villages...."[18] But this productivity effect was more pronounced for landed households in all six villages. This, of course, implies that benefits were skewed toward landed households. However, the Jha Report notes that "...only the relatively well-off people [can] afford to have their own cows or buffalo."[19] Moreover, figures in NDDB show that in the milksheds of Operation Flood, the landless compose 39 percent of all households but produce only 11 percent of the milk.[20]

Shah points out that "...no mechanisms exist to make the impact nonneutral to scale; whatever benefits accrue to the members [of a cooperative] in terms of [a] higher price [for milk] are strictly in proportion to the milk production of the member producers...."[21] He concludes, therefore, that there is not a strong orientation toward the rural poor in dairy development projects. This, however, refers to the effect of prices, not of technology transfer.

Although producers receive a fairly high share (about 73 percent) of the consumer price,[22] critics such as George claim that benefits to producers are held down by low producers' prices.[23] These low prices, they claim, are the result of high fixed and variable costs in the dairy cooperative society structure and of inefficiencies and diseconomies in the cooperative milk collection and marketing system. These critics claim that the costs of marketing are much lower in traditional milk processing and marketing and that the latter, being undertaken mainly by women, allows women greater control over the resulting income. Although George cites evidence on traditional marketing costs, she does not recognize the inherent scale limitations and inability to handle very large volumes of milk. Moreover, her assertions about weaknesses in the cooperative system are not adequately substantiated. More substantial evidence provided in the Jha Report shows that subsidies to consumers in some metropolitan cities depress the producer price and thus reduce benefits to producers.[24]

Most linear programming and farm-management studies indicate that potential benefits will accrue to the poor from the introduction of a dairy enterprise and that these benefits are closely related to the number of milk animals small producers can afford to keep.[25] But studies using these methods merely ask whether dairying can improve the incomes of the rural poor; they do not examine actual project effects.

Moreover, the normative conclusions from linear programming studies are quoted in some parts of the literature as if they were derived from ex-post analyses.

Not all poor families, landed or not, are engaged in dairying, and not all of those who keep milk animals can afford milk animals of high productivity. Some of the factors that affect the decision of the farmer to keep milk animals are feed availability, credit availability, and the household's ability to accept production and income risk. The feed availability constraint may be alleviated by improved cash flow, which may allow the feed concentrates required for high-productivity milk animals to be purchased. Marketing channels for feed must also be reliable. But in the context of income distribution, the credit and risk constraints are likely to be much more important, and little empirical evidence exists on the effects of these constraints on the participation rates of the poor and near poor in dairy development projects.[26]

The availability of institutional finance for dairy development has been studied by George and Srivastava who find, in the specific cases examined, that institutional financing of dairy development schemes is viable and feasible and provides the means for poor people to profitably acquire milk animals and therefore improve their income.[27] Although they conclude that "the pattern of loan distribution and additions to the breeding stock indicates that the cattle development scheme was not one which increased the gap between the rural poor and the rural rich," their data indicate that marginal and landless farmers receive a disproportionate share of dairy loans. It is clear, then, that even this evidence is weak, and that much more sharply focused and rigorous studies are needed if a properly informed understanding of the distributional issues, as they affect dairy producers, is to be obtained.

Bowonder et al. comment that the progressive distributional aspect of dairy development they observed was primarily due to a government credit program.[28] Since such programs are not part of Operation Flood, these comments are more relevant to other dairy development schemes. Targeted credit programs are not incompatible with cooperatives and indeed may be synergistic. They are, however, distinct.

DISTRIBUTION OF GAINS TO CONSUMERS

Apart from influencing the incomes of producers, wage laborers, and the suppliers of dairy production inputs, Operation Flood may also affect consumers through changes in the price they pay for milk. Such changes in consumer welfare can be measured by estimating values, such as consumer surplus or compensating and equivalent variation. It is not necessary, however, to delve into the nuances of such measures of welfare gain to derive useful guidance for food policy or agricultural research.[29] Clear indications of the potential distribution of the

benefits consequent on changes in the prices of commodities affected by increased dairy marketing and production (for example, dairy products and cereals) can be obtained by examining existing household budget shares to these commodities. Ex-post, of course, is also necessary to determine whether prices have changed before any measure of change in consumer welfare can be derived.

There can be little dispute about the potential distribution of real income gains following a fall in the price of fluid milk. In India, as indicated in Table 3, the consumption of milk is highly skewed toward the upper-income groups--a phenomenon that predates and cannot, therefore, be attributed to Operation Flood. Similar data from 1980 indicate large differences in average consumption in different states; for example, average daily consumption of milk per expenditure unit in rural Orissa was 16.5 grams, while it was 112.5 grams in neighboring Andhra Pradesh.[30] Yet in each state the pattern of increasing milk consumption with increasing income is quite apparent and far more pronounced than increases in cereals or in calories and proteins. Since the change in consumer surplus following a price change is roughly proportional to initial levels of consumption, the greatest share of benefits goes to the upper-income groups. This point has been widely acknowledged, for example, in the generally favorable World Food Programme evaluation of Operation Flood cited by Lipton.[31]

Table 3--Expenditure on dairy products, 1973/74

Monthly per Capita Expenditure Group	Rural		Urban	
	Expenditure	Sample Proportion	Expenditure	Sample Proportion
(rupees)	(rupees)	(percent)	(rupees)	(percent)
0 - 18	0.12	1.6	0.70	0.4
18 - 21	0.24	1.7	0.25	0.3
21 - 24	0.42	2.7	0.65	0.8
24 - 28	0.51	4.8	0.83	2.1
28 - 34	0.96	10.3	1.51	5.3
34 - 43	1.74	17.8	2.32	11.9
43 - 55	3.10	20.1	3.72	16.3
55 - 75	5.22	20.5	6.03	20.9
75 - 100	8.19	11.0	8.92	15.9
100 - 150	13.44	6.6	13.21	14.8
150 - 200	17.10	1.6	19.21	5.9
200 +	26.12	1.1	25.98	5.2

Source: India, Department of Statistics, National Sample Survey 28th Round (October 1973-June 1974), Report 240 (New Delhi: Department of Statistics, 1977).

However, an assessment of the effect of dairy development on consumers' welfare should include the effects on prices, other than the price of fluid milk, that are attributable to dairy development. While a reduction in the price of fluid milk "holding other prices constant" cannot lower and will generally raise consumers' welfare, the net effect is uncertain if dairy development also raises other prices. The resulting changes in economic welfare when more than one price changes are more difficult to calculate. However, the prices (other than milk) most likely to be affected by dairy development are those of the coarse grains, since they are used as animal feed. They are also commonly eaten by the poor (see Table 4). Thus, if dairy development does operate to increase the price of coarse grains, this is likely to further skew benefits in favor of the relatively rich. There seems, however, to be no evidence relating dairy development to grain prices.

Table 4--Consumption of selected coarse grains, 1973/74

Per Capita Monthly Expenditure Group	Rural				Urban			
	Sorghum	Maize	Bajra	Ragi	Sorghum	Maize	Bajra	Ragi
(rupees)	(kilograms per month)							
0 - 18	1.08	0.87	0.39	0.39	0.52	0.08	0.85	0.01
18 - 21	1.48	1.12	0.49	0.48	2.11	...	...	0.14
21 - 24	1.76	0.74	0.77	0.63	1.00	0.22	0.19	0.28
24 - 28	1.89	0.79	0.87	0.59	1.87	0.23	0.63	0.22
28 - 34	1.84	1.04	0.95	0.57	1.37	0.26	0.68	0.20
34 - 43	1.83	0.85	1.12	0.44	1.14	0.18	0.65	0.15
43 - 55	1.65	0.94	1.24	0.46	0.91	0.14	0.39	0.10
55 - 75	1.42	0.83	1.39	0.48	0.83	0.16	0.48	0.12
75 - 100	1.33	0.97	1.45	0.69	0.62	0.07	0.41	0.11
100 - 150	1.28	0.78	1.92	0.70	0.44	0.07	0.24	0.09
150 - 200	1.75	0.66	1.03	0.85	0.22	0.04	0.07	0.03
200 +	1.41	0.76	0.92	2.03	0.14	0.02	0.03	0.03

Source: India, Department of Statistics, National Sample Survey 28th Round (October 1973-June 1974), Report 240 (New Delhi: Department of Statistics, 1977).

Similar consequences can be expected regarding changes in buttermilk prices. Although there is less evidence about the consumption of this product (see below), it is commonly assumed to be predominantly consumed by the poor. Dairy development is widely hypothesized to lead to a reduction in the supply of buttermilk and hence to higher prices. This is, according to commentators such as George, because the in-

creased marketing leaves less milk for ghee production, of which processed buttermilk is a residual product.[32] If these assumptions are correct, the distribution of consumer benefits resulting from dairy development will be further skewed in favor of the upper-income groups.

The measurement of the effects on consumer welfare of price changes such as these is handicapped by the lack of agreement as to which changes in prices can be attributed to Operation Flood. One critic of Operation Flood claims that "the sale of reconstituted EEC milk enables the Indian Dairy Corporation to pay a higher price than it could otherwise for milk in the village."[33] It is ironic that this is depicted as a criticism of the program, but it is at least more consistent than George's view that Operation Flood does not raise real producer prices yet induces producers to increase the supply of milk to the market.[34] Unless there are widespread forced sales, tied agreements, or other institutional constraints, these two assertions are hard to reconcile. (The rebate of a portion of cooperative profits [the dividend] that is proportional to sales can be considered as a component of the sales price.)

It is possible, even likely, that new marketing channels can raise the milk price in rural areas while lowering it in urban markets. The common rhetoric is that dairy cooperatives eliminate the abnormal profits taken by middlemen, but there is little evidence that middlemen have the market power to extract such profits. Nyholm et al., in a report on the Bangalore milkshed, report that middlemen still mediate between producers and cooperatives but the margin is small.[35] Singh and Kelley give evidence that the Anand cooperative differed little in its purchasing patterns from the Polson dairy.[36] It is likely, then, that cooperatives operate to reduce the costs of marketing through scale economies. Such savings as well as possible price reductions resulting from increased production within a milkshed, may, combined with the direct effect of food aid, reduce urban prices.

Both Lipton and Terhal and Doornbos argue that dairy aid, an integral component of Operation Flood, depresses producer prices.[37] Lipton estimates this price reduction to be between 8 and 21 percent based on the ratio of aid to marketed surplus. (This is likely to be an overestimate if the marketed surplus is price-responsive.) Nevertheless, a more important issue is raised by Terhal and Doornbos; they note that while food aid increases the local availability of milk, urban prices are basically set by the state and municipal governments and tend to be kept low. Jul attributes this to political pressures.[38] Thus the availability of food aid may help to reduce the pressures on the government to raise prices, yet the milk market in urban areas is unlikely to be in a price equilibrium. In such disequilibrium situations, the relationship of increased supply to local prices is not straightforward. Moreover, the resources that a consumer must allocate to purchase milk may not be measured by the rupee cost alone. Milk rationing has been common in cities and queuing has been necessary to obtain the available supply.[39] Since studies of the urban

milk market have neither explored the extent and characteristics of disequilibrium (if this is the nature of the market) nor documented the relative scale of the noncooperative market (according to the Jha Report, the latter is thought to be about 50 percent in the four metropolitan cities of Delhi, Calcutta, Madras, and Bombay),[40] the full extent of the effect of Operation Flood on consumer prices in urban areas is not clear.

Because increased grain production over the last two decades has affected imports more than per capita availability, analysis of the current and potential demand, supply, and trade of coarse grains is necessary before a clear measure of the effect of any change (attributable to dairy development) in the use of such coarse grains can be determined. Moreover, from what is known about present marketing channels and costs, local price effects due to increased dairying may deviate substantially from the national average effect, although evidence is not readily available.

NUTRITIONAL EFFECT

Much of the debate on the effect of Operation Flood has focused on the effect of dairy cooperatives on the protein intake of both consumer and producer families. From a purely economic perspective, the distribution of benefits could be measured by the real income gains discussed above. However, since it is often believed that increased consumption of food by the poor brings positive externalities for society in the form of increased human capital and improved health, some analysts of Operation Flood have examined specific food and nutrient intakes. The utility-maximizing decisions of households may not, however, result in a distribution of food resources that is proportional to nutritional need.[41] Specifically, increases in the total economic welfare of a household may not translate into improved nutrition for the most vulnerable members of the household--children and pregnant women. Accordingly, much of the argument about the nutritional consequences of dairy projects is concerned with changes in the pattern of food purchases and distribution.

This still leaves the question of whether the proper focus of inquiry should be milk consumption or nutrient consumption. This issue is somewhat clouded by the oft-cited recommendation of the Indian Council of Medical Research that an average per capita availability of 180 grams of milk daily would be adequate to balance the diets of both the vegetarian and nonvegetarian sections of the Indian population.[42] The logic of this recommendation is not obvious. First, average availability indicates little about the consumption of those who are nutritionally at risk. As shown in Table 3, the consumption of dairy products by the poor is a small fraction of the national average intake. Second, although milk has a particular importance in the diets of infants,[43] it is not a biological requirement, nor is "animal" protein, or what George calls "lactic" protein.[44] Although milk is a

digestible source of protein, combinations of pulses and grain can also provide equivalent protein at lower unit cost than dairy products.[45] Indeed, during the inception and implementation of Operation Flood I and II, protein policy guidelines were less rigid than is reflected in the writings of either the supporters or the critics of dairy development. As a result of a number of studies in the early 1970s, which indicated that protein intake was generally adequate when caloric consumption met prevalent standards for intakes,[46] greater emphasis was placed on raising energy intakes.[47] This emphasis has been questioned during revisions of protein requirements and by the recognition that caloric requirements, unlike those for protein, reflect a normative judgment about appropriate energy levels.[48] Hence, the useful question in regard to the nutritional effect of dairy development is whether total energy and protein intake is affected, but little is known about this matter.

Agricultural development can influence the nutrition of an individual by affecting (1) the amount and kinds of food available in the market or on the farm at a given time and place, (2) the ability of the household--of which the individual is a member--to obtain available food, (3) the desire of the head of the household to obtain food to which he or she has access, (4) the allocation of the required food among household members, and (5) the physiological utilization of ingested food by the malnourished individual.[49]

Regarding the first of these factors, milk availability, the evidence has been reviewed in earlier sections. Evidence on the second has also been reviewed but some recapitulation is necessary. Clearly as income goes up, the ability to purchase food increases, and in India the propensity of the poor to purchase food out of additional income is among the highest in the world.[50]

The income effect can, however, be offset by reduced availability, which would lead to higher prices. As indicated above, such price effects are not well documented. However, evidence on changes in marketed surplus--contrary to George, who also claims there is a reverse response to price--is not evidence of reduced availability at the farm.[51] For example, while Thakur reports that villages with cooperatives have a higher marketed surplus of milk than villages without cooperatives, he does not report whether production increased in those villages.[52] In three two-group comparisons, Singh and Das found production and the marketed surplus to be higher in villages with cooperatives than in villages without them.[53] Even holding production constant, marketed surplus may increase or decrease following a price change, depending on the relative magnitudes of the income and price elasticities. The effect of a price rise on real income--hence, on ability to acquire food--is nevertheless positive for net producers. Even for nonproducers, the net calorific effect of an increase in milk prices may be ambiguous. For example, Selowsky shows how the cross-price effect of milk prices on grain consumption can override the own-price effect, giving a net positive effect on total calorie intake

following an increase in milk prices.[54] Pitt, however, observes a small but negative net effect for rural Bangladesh.[55]

Because buttermilk is less expensive than milk, its role in the diets of the poor may differ from that of milk. Furthermore, as the markets for buttermilk are thin, a switch from household production of ghee to widespread marketing of fluid milk may have a major effect on the availability of buttermilk. George cites research that documents the importance of buttermilk distribution to laborers by feudal landlords in Haryana, but the same report did not find buttermilk to be important in a village without a cooperative in Kerala.[56] Somjee and Somjee describe the buttermilk issue as "phony" but offer no evidence for their statement.[57] Indeed, there is little data on the role of buttermilk in the diets of the poor. Although it is sometimes given to laborers, the prevalence of this practice is not known. Nor, even if widespread, is it known whether wages, in kind or otherwise, have adjusted to compensate for changes in buttermilk availability. The net nutritional effect of changes in the supply of buttermilk is, therefore, still a matter of conjecture.

Turning now to the third point above, it may be asked: Does the existence of a dairy cooperative influence the desire of a household to obtain food? Since it may influence the potential return to investment and hence the propensity to consume out of current income, it may have an effect on the nutritional status of some family members, but there is little evidence. Nor is there evidence that changes in the timing or the manner of payment for milk influence a household's consumption pattern. Mehta, drawing on evidence from nutritional surveys in the Kheda district of Gujarat, concludes that although dairying had a positive effect on the generation of cash income, the majority of children remained undernourished.[58] This indicates merely that dairy development has not eliminated malnutrition, not that such development contributes to it. Other commentators suggest that families dependent on dairying tend, with increasing milk sales, to substitute the consumption of pulses and vegetables for milk. The net impact of such arbitrage on nutrient consumption is positive.[59]

There is evidence from some cooperatives that women have taken a more active role in milk marketing after the formation of a dairy cooperative, but it is not known whether this has influenced household purchasing patterns or the intrafamily distribution of food (point 4 above).[60] Similarly, nothing is known about the effects of dairy development on the physiological processes of eating (point 5 above).

Finally, a related issue concerning nutrition merits mention. Although most European Economic Community aid in the form of powdered milk is reconstituted to fluid milk, dairy development also includes the promotion of a domestic powdered-milk industry. The cooperative sector dominates the production of milk-based infant foods.[61] At present there seems to be no evidence that the development of this market has contributed to a decline in the incidence of breastfeeding in the

cities or elsewhere. Nevertheless, such a decline is a serious nutritional problem in a number of countries and deserves study in India.

In summary, the paucity of evidence about the effects of dairy development on nutrition allows both proponents and critics to make unsubstantiated claims. However, changes in the consumption of milk--an item that is not generally a major or cost-effective source of nutrients for the poor--should not be central to the evaluation of Operation Flood. Of much greater importance is the program's effect on production, incomes, and total intake of calories and protein. Firm evidence on these matters would allow a more informed debate on appropriate pricing policies.

NOTES

[1]Institute of Rural Management, "Profiles in Development."

[2]Such studies are, however, notoriously difficult to conduct successfully (Casley and Lury, Monitoring and Evaluation of Agriculture).

[3]Shah, "Economic Impact of Operation Flood," p. 28.

[4]Thakur, "Impact of Dairy Development"; and M. B. Desai and S. K. Varma, An Evaluation of Dairying Assistance Programme (Baroda, India: Department of Agricultural Economics, Faculty of Arts, University of Baroda, 1978).

[5]See Sirohi et al., "Role of Dairy;" A. S. Kahlon, K. C. Dhawan, and G. D. Gill, "Relative Profitability of Dairy Enterprise vis-à-vis Crop Cultivation in the Punjab," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 120-128; and Pandey and Bhogal, "Prospects of Increasing Income and Employment."

[6]Sirohi et al., "Role of Dairy."

[7]See Carl H. Gotsch et al., "Linear Programming and Agricultural Policy: Micro Studies on the Pakistani Punjab," Food Research Institute Studies 14 (No. 1, 1975): 3-106, for a discussion of the effects of inadequate refinements of the minimum constraints on the optimal solution.

[8]See Gotsch et al., "Linear Programming and Agricultural Policy," for a discussion of the importance of the shadow prices of the constraints.

[9]See, for example, Raut, Singh, and Rustogi, "Comparative Economics of Rearing Cross-Bred and Non-Descript Calves;" and N. A. Gadre and B. G. Sapate, "Impact of Dairy Projects on Rural Economy: A Case Study," Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 173.

[10]Patel, "Rapporteur's Report on Economics of Livestock Enterprises," p. 180.

[11]van Dorsten, The Rural Impact of Operation Flood, p. 62.

[12]See, for example, Jul, "Comments on Operation Flood, 1985."

[13]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II, Appendix 5.1.

[14]Vaidyanathan, "Aspects of India's Bovine Economy."

[15]M. P. Moore, "Some Microeconomic Aspects of the Livestock Economy," Indian Journal of Agricultural Economics 33 (No. 1, January-March 1978): 67-76, qualifies this result, however, by noting that small farmers are heavily dependent on public pasture, the use of which is not valued in his analysis.

[16]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[17]Institute of Rural Management, "Profiles in Development."

[18]Singh and Das, "Impact of Operation Flood I at the Village Level," p. 104.

[19]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II, p. 50.

[20]National Dairy Development Board, "Dairying in India," NDDB, Anand, India, 1982.

[21]Shah, "Economic Impact of Operation Flood," p. 27.

[22]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[23]George, "Operation Flood and Rural India."

[24]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[25]Singh and Singh, "Impact of Dairy Enterprises."

[26]Sidhu, "Rapporteur's Report on Dairy Development;" and Patel, "Rapporteur's Report on Economics of Livestock Enterprises."

[27]P. S. George and V. K. Srivastava, "Institutional Finance for Dairy Development," Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 90-96.

[28]Bowonder et al., "Impact of Dairy Development Programs."

[29]Per Pinstrup-Andersen, "Decisionmaking on Food and Agricultural Research Policy: The Distribution of Benefits from New Agricultural Technology Among Consumer Income Strata," Agricultural Administration 12 (No. 1, 1977): 13-28.

[30]National Nutrition Monitoring Bureau, "Food and Nutrient Consumption Patterns in the Selected Districts of Different States--1980," National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, 1981.

[31]Lipton, "Indian Agricultural Development and African Food Strategies."

[32]George, "Operation Flood and Rural India."

[33]Raymond Crotty, "Operation Flood and the EEC," Economic and Political Weekly (April 1983): 522.

[34]George, "Cooperatives and Indian Dairy Policy."

[35]Nyholm, Schaumberg-Muller, and Westergard, "Socioeconomic Aspects of Dairy Development."

[36]Singh and Kelley, AMUL: An Experiment in Rural Economic Development.

[37]Lipton, "Indian Agricultural Development and African Food Strategies;" and Terhal and Doornbos, "Operation Flood."

[38]Jul, "Comments on Operation Flood, 1985."

[39]For a discussion of the resource cost of queueing, see Yoram Barzel, "The Theory of Rationing by Waiting," Journal of Law and Economics 18 (1974): 73-95.

[40]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

[41]Per Pinstrup-Andersen, Norha R. de Londoño, and Edward Hoover, "The Impact of Increasing Food Supply on Human Nutrition: Implications for Commodity Priorities in Agricultural Research and Policy," American Journal of Agricultural Economics 58 (No. 2, May 1976): 131-142.

[42]National Dairy Development Board, Breeding and Feeding.

[43]Huria and Achaya, "Dairy Development in India."

[44]George, "Cooperatives and Indian Dairy Policy."

[45]Chatterjee, Aid, Trade, and Rural Development.

[46]P. V. Sukhatme, "Incidence of Protein Deficiency in Relation to Different Diets in India," British Journal of Nutrition 24 (1970): 447-487.

[47]James Ryan, A. Sheldrake, and S. Yadev, Human Nutritional Needs and Crop Breeding Objectives in the Semi-Arid Tropics, Economics Program Occasional Paper 7 (Hyderabad, India: International Crops Research Institute for the Semi-Arid Tropics, 1974).

[48]George Beaton, "Energy in Human Nutrition: Perspective and Problems," Nutritional Review 4 (1983): 325-340.

[49]See Per Pinstrup-Andersen, "The Impact of Export Crop Production on Human Nutrition," in Nutrition and Development, ed. M. Biswas and P. Pinstrup-Andersen (London: Oxford University Press, 1985). Without separating out differences in prices, incomes, and demographics, paired village studies, such as Bowonder et al., "Impact of Dairy Development Programs," give little information on the causes and observed differences between group averages.

[50]K. N. Murty, Consumption and Nutrition Patterns of ICRISAT Mandate Crops in India, Economic Program Progress Report No. 3 (Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 1983).

[51]George, "Operation Flood and Rural India."

[52]Thakur, "Impact of Dairy Development."

[53]Singh and Das, "Impact of Operation Flood I at the Village Level."

[54]Marcelo Selowsky, "Target Group-Oriented Food Programs: Cost-Effectiveness Comparisons," American Journal of Agricultural Economics 61 (No. 5, December 1979): 988-994.

[55]Mark Pitt, "Food Preferences and Nutrition in Rural Bangladesh," Review of Economics and Statistics 65 (No. 1, 1983): 105-114.

[56]Shanti George, "Diffusing Anand: Implications of Establishing a Dairy Cooperative in a Village in Central Kerala," Economic and Political Weekly (December 1984): 2161-2169.

[57]Somjee and Somjee, "Cooperative Dairying and the Profiles of Social Change in India."

[58]Mira Mehta, "The Impact of Kheda District Milk Cooperatives on Protein Energy Malnutrition in Rural Indian Preschoolers," Ph.D. thesis, Cornell University, Ithaca, New York, 1981.

[59]National Dairy Development Board, "Nutritional Impact of Operation Flood," Indian Dairy Corporation, Anand, India, 1983 (mimeographed), pp. 1-20.

[60]Somjee and Somjee, "Cooperative Dairying and the Profiles of Social Change in India."

[61]India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II.

6. CONCLUSIONS AND MICROECONOMIC RESEARCH PRIORITIES

In previous chapters, the origins of the Indian dairy cooperative system have been described and the evolution of Operation Flood has been outlined. A review has been made of the arguments of supporters and critics and of the evidence upon which these arguments are based. What then has been learned?

It is clear that Operation Flood (in all its phases) is an ambitious program, but with potential to match. The scale of its operations and the social and economic changes it seeks to induce are large, even making allowance for the size of the Indian agricultural sector. It is not, therefore, surprising that the program is controversial. Although a number of studies have been undertaken, it is surprising that the information so far collected on the effect of Operation Flood is so lacking in scientific rigor and, thus, that most of the arguments, both favorable and unfavorable, are not adequately sustained by the available evidence.

From an institutional viewpoint, the essence of Operation Flood is the widespread emulation of the AMUL cooperative. The extent to which the AMUL cooperative has been genuinely replicated is unclear despite the claims of those who have studied the issue. The debate is conducted in largely sociopolitical terms and is much concerned with the cooperative model in Anand and the (apparent) loss of purity in the expansion under Operation Flood. In its broadest form this argument is of little value, given the paternalist nature of government policy toward cooperatives. Centralization allows for expansion according to a blueprint, but reduces flexibility to adapt to local conditions. At the microlevel the debate provides useful information on how rural cooperatives work (or do not work) in India. Only very modest efforts, however, have been made to explore alternatives to the cooperative model as a vehicle for dairy development. Moreover, few observers note the benefits that may be derived from improved market intelligence and marketing structures, such as those associated with Operation Flood, but that do not depend on a cooperative form of organization. Similarly, the question of whether such marketing improvements could be provided without large-scale public investment is not adequately addressed.

Apart from its institutional objectives, Operation Flood aims to further India's policy of increasing milk production mainly through technological change. The program's main focus is the introduction of improved production, marketing, and processing technology. To increase production, Operation Flood relies heavily on the adoption of crossbred cows by milk producers, but only modest progress has been made. If,

however, the share of crossbred cattle in the national milk herd rises substantially, this could put upward pressure on feed prices or increase imports, or both, and thus induce more widespread changes in relative prices. The literature provides little evidence that such input supply and price issues have been properly analyzed.

Under Operation Flood, increased production and cooperative marketing by milk producers has relied on the investment of large sums in capital-intensive dairy processing plant. The dairy industry, however, is not yet able to finance such investments from internal surpluses and plans to rely heavily on external, largely concessional, finance for the next few years. There is some evidence that some of the fixed assets so far created are underutilized. This tends to reduce the ability of the industry to profitably borrow and deploy commercial funds. The economic effects and the desirability of dependence on concessional, largely food, aid is the source of much argument, which has been largely ignored in this review.[1,2]

In India, cattle are kept primarily as a source of draft power; buffalo are the main milk producers. Recent evidence suggests that increasing milk production is primarily due to a long-term secular trend toward buffalo in the national herd. This trend seems to be due to the greater feed-conversion efficiency of buffalo compared to cows, the increased availability of crop residues, and increased farm mechanization. This trend has been observed in all-India data and, more specifically, in Gujarat, where intensive dairy activities date back to the late 1940s, and in the Punjab, where public-sector dairy development activities have been minimal. However, the strategy of Operation Flood and the dairy development projects was to go directly from a farming system, where the local cow dominates, to one based on the crossbred cow, bypassing altogether the stage where the buffalo is the main milk animal. It has been shown that this did not happen in Anand. There are indications also in the literature that this may not be a feasible strategy and the NDDB is now giving increased attention to the role of buffalo in dairy production.

Overall, the evidence reviewed suggests that the main determinant of increased milk output may be an improvement in the productivity of the existing milk stock through better feeding and husbandry practices. Therefore, to the extent that dairy development activities directly or indirectly affect feeding and husbandry practices, they may have a substantial effect on milk supply. The availability of animal feed is thus an important issue. There is evidence suggesting that the availability of feed is a major constraint to dairy development. Increased fodder cultivation does not seem to be a solution favored by farmers, since the introduction of fodder crops has not become widespread. There is no evidence in the literature about the reasons for the poor acceptance of fodder crops.

Traditionally, the milk marketing system has depended upon the irregular collection, transport, and sale of milk by private traders.

The volume of milk that such a system can handle is limited by the seasonality of production, the perishability of the product, and the large capital investments required to establish processing and marketing facilities in the cities. Such capital investment is generally beyond the means of small-scale private traders, but private dairy plants have been developed in areas such as the Punjab and in the major cities.

The dairy development projects intervene in the traditional milk production and marketing system by establishing village marketing outlets for the year-round collection of milk at established prices. The village cooperative provides inputs, artificial insemination services, and technical information that enable farmers to increase production.

Existing empirical evidence on the effect of specific dairy development projects is generally inadequate. There are no longitudinal studies that separate specific project effects from secular trends. However, several studies have assessed project effect by comparing one group of farms exposed to the project with another group that was not and have found that most of the differences favored the villages in the project.

Because these conclusions were reached on the basis of simple comparisons of averages without formal statistical testing of differences between means or testing for biases in sample selection, the results are only indicative.

Other studies have used econometric and other techniques to assess the actual or potential effect on milk output of the introduction of crossbred cows, changes in numbers of milk animals, and better feeding. These studies show that crossbred cows and buffalo are markedly superior to local cows. The introduction of crossbred technology is, among other things, highly dependent on an efficient artificial insemination program. This program, however, has been slow and its effectiveness highly debated.

The poor acceptance of crossbred cows is attributed to the scarcity of fodder, the belief that crossbred bullocks are not good draft animals, and the limited resources available to small farmers. There is evidence that crossbred cows require substantially higher feed inputs than local cows, but the claim that technical knowledge is not well diffused is unsubstantiated. Crossbred animals are expensive and farmers appear reluctant to purchase them because of higher risks of disease and mortality and the need for careful management. These matters have not been satisfactorily examined in the literature.

Better feeding is a major and widely documented source of increased productivity in milk animals. Where dairy development projects can induce better feeding, substantial increases in milk yields should result.

Dairy development projects have three main potential links to the cropping system: the shift of labor and land resources from crop production to dairy activities; the effect of increased milk sales receipts on cash constraints in crop production; and the effect of new dairy-management concepts on the adoption of new technology in crop production, and vice versa. Of these three links, only the first has received much attention, primarily in relation to possible changes in the demand for labor.

One study concluded that the total labor demand for dairying is primarily determined by the number of milk animals kept. If that conclusion is generally applicable, a dairy development project that results in a large increase in the number of animals will also cause a significant increase in the demand for labor. But if the main effect of dairy development projects is on productivity, the labor-demand link is likely to be much weaker.

The incomes of milk producers who are participating in dairy development projects are affected by the additional milk output, the cost involved, and the degree of interaction between the dairy and cropping activities. Moreover, a distinction must be drawn between absolute and relative income changes. Although the projects may have a positive effect on average incomes and on the incomes of the poor, these income changes may not be equally distributed. The income effects of dairy development have been explored in a number of studies. These studies, which are linked to those mentioned earlier, are usually based on simple comparisons and concentrate on measurement of the following indicators: the quantity of milk marketed and the prices received, the revenue from milk and milk products, and the costs of milk production. The results typically show higher milk prices, a greater quantity of marketed milk, and higher revenues from milk sales in villages with dairy cooperatives. These studies also show the cost of production to be higher in villages with cooperatives than in those without. However, these conclusions are only indicative, since the comparative basis of the analysis precludes any inference of causality. Additionally, these studies use evidence from single-visit surveys rather than from annualized revenue and expenditure data from several visits. Moreover, they consider neither interactions with the cropping system nor changes in the level and composition of crop output.

The distribution of bovine ownership in India is more even than the distribution of land ownership, and more milk animals per unit of land are kept by small and marginal farmers than by large farmers. Thus, among those who own or rent land, dairy activity output is more evenly distributed than crop activity output. Hence, several authors maintain that dairy development has a large positive distributional effect. Nevertheless, the few studies that have addressed this issue conclude that benefits from dairying are biased toward landed households, or at least that there is no strong orientation toward the rural poor; these conclusions are handicapped by significant methodological weaknesses. Other, mainly linear-programming and farm-management,

studies suggest that the benefits realized by the poor from dairy development will depend entirely on the number of animals they keep. However, these studies ask only whether the incomes of poor farmers can be improved by dairying and do not examine the actual effects of dairy development projects. Moreover, the normative conclusions from linear programming studies are quoted in some parts of the literature as if they were derived from ex-post analyses; they were not.

Among poor families who engage in dairying, not all can afford high-productivity animals. Whether or not poor farmers keep milk animals at all depends on the availability of feed and capital and on their ability to accept production and income risk. Improved cash flow may relieve the feed constraint, but in the context of income distribution, capital and risk are probably the more important constraints, and there is little empirical evidence as to how these constraints affect the participation and welfare of poor households in dairy development projects.

Aside from the influence of Operation Flood on the incomes of producers, wage laborers, and suppliers of dairy-production inputs, consumers may be affected by the program through changes in the price they pay for milk. The potential distribution of real income gains after a fall in fluid milk prices can scarcely be disputed. The consumption of milk in India has been highly skewed toward upper-income groups since long before Operation Flood. Because the change in consumer surplus following a price change is roughly proportional to initial consumption levels, upper-income groups reap the largest benefits. Although a reduction in fluid milk prices never lowers and usually raises the welfare of consumers, the net effect if dairy development also raises other prices has not been rigorously studied. The effect that dairy cooperatives have on the protein intake of consumer and producer families has been the focus of much debate. Some analysts have examined this problem from a purely economic perspective; others have studied specific food and nutrient intakes. Much of the discussion about the nutritional consequences of dairy development projects concerns changes in food purchase and distribution patterns. The most useful question about the nutritional effect of dairy development is whether the total energy and protein intake is affected, but little is known about this matter.

In general, the paucity of evidence about the effects of dairy development on nutrition allows both proponents and critics to make unsubstantiated claims. However, changes in the consumption of milk--an item that is not generally a major or cost-effective source of nutrients for the poor--should not be central to the evaluation of Operation Flood. Of much greater importance is the program's effect on production, incomes, and total nutrient consumption. Firm evidence on these aspects would allow a more informed debate on the welfare effects of Operation Flood and on the development of appropriate policies.

MICROECONOMIC RESEARCH PRIORITIES

The need for more information and rigorous study if the effect of Operation Flood is to be objectively determined has been repeatedly noted in this paper. At the aggregate level, further review of the constraints to dairy development (capital and fodder supplies in relation to the composition of the national herd) are clearly necessary. At the farm-household level too, much microeconomic evidence is needed. Indeed, it can be convincingly argued that the true test of Operation Flood, or any other project, is whether it increases the welfare of those directly and indirectly affected. Thus there are a number of issues worthy of serious research and investigation, which are listed below in the form of a series of questions.

Direct Output Effects

Operation Flood (the project) aims to increase aggregate milk production significantly. This suggests the following specific questions:

1. Have milk yields increased significantly as a result of the project?

2. Has the size or the composition of the dairy herd changed significantly as a result of the project?

3. Has the number of crossbred cattle owned by households in the project area increased through purchases or through breeding as a result of project activities?

4. The ownership of dairy cattle is positively correlated with land ownership. Has the number of crossbred cattle owned by landless households increased because of the project?

5. Is the primary source of expansion of milk production increased yields or growth in the size of the herd?

Indirect Output Effects

These questions relate to the effects of the project on the production of other agricultural products, such as foodgrains:

1. Has income from milk sales increased as a result of the project? And, if so, operating through a relaxation of the cash flow constraint, has the project induced increased purchases and use of modern inputs in foodgrain production among project participants?

2. Is the magnitude of any increase in the purchase and use of modern inputs for foodgrain production positively correlated with the

length of time that the household has participated in (or has been exposed to) the project?

3. Has the project caused a significant increase in the area devoted to fodder crop production among project participants?

4. Even if more land is in fodder as a result of the project, has the use of modern inputs in foodgrain production increased, resulting in an overall increase in foodgrain production?

Effects on Milk Consumption

The following questions are important:

1. Has milk consumption by low-income milk-producing households declined because of the project? (The basis of this question is that the effect on milk consumption of the rise in the price of milk may be greater than the income effect.)

2. Does the milk supply to consumers in rural areas initially fall because of the project? (This question implies that the transfer of milk from rural to urban areas at least initially exceeds the increase in production due to the project.)

Effects on Household Consumption and Nutrition

These questions are related to the consumption effects of the project. Specifically, they are concerned with aggregate calorie and protein consumption among milk-producing households (both landed and landless):

1. What is the share of incremental household income generated by the project that is spent on the purchase of additional food?

2. Does any increase in the consumption of purchased and home-grown calories and protein significantly exceed any reduction in calorie and protein consumption resulting from the sale of milk and dairy products hitherto consumed? (That is, does the income effect on food consumption override the loss of calories that results from sales of milk and milk products by milk-producing households?)

Distribution of Benefits to Milk Producers

These questions are related not only to the aggregate project effect on incomes but also to the way in which income changes are distributed among milk producers. Specifically, because many households have no cattle before the project, it should be established whether the proportion of households with milk animals has increased:

1. Has the proportion of households with milk animals increased as a result of the project?

2. Have poor households been induced to start a dairy enterprise as a result of the project?

3. Are the net returns from increased milk production due to the project different for households in different classes?

Reliable and well-researched answers to all or at least some of these questions would permit most of the myriad claims and counter-claims about the effects of Operation Flood to be more objectively reviewed and accepted or rejected. These questions can be addressed if empirical evidence is collected through a conceptually complete evaluation framework that provides information not only about the with- and without-project situation, but also collects information before and after the introduction of the project. Subsequent analysis will require rigorous statistical and econometric procedures that allow the influence of confounding effects to be controlled.

NOTES

[1]Hannan Ezekiel, "The Role of Dairy Food Aid in Economic and Social Development," International Food Policy Research Institute, Washington, D.C., March 1987 (mimeographed).

[2]Edward Clay and Mark Mitchell, "European Community Food Aid in Dairy Products is Cost-Effective," European Review of Agricultural Economics 10 (1983): 97-121.

BIBLIOGRAPHY

Acharya, R. M. "Strategy for Breeding Dairy Cattle in India for Enhanced Milk Production." Indian Dairyman 31 (No. 9, 1979): 607.

Achaya, K. T., and Huria, Vinod K. "Rural Poverty and Operation Flood." Economic and Political Weekly (September 1986): 1651-1656.

Achaya, K. T., and Pawar, T. G. "The Economics of Milk Production by Different Types of Milch Animals." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 153.

Alvarez, Claude. "Operation Flood: The White Lie." The Illustrated Weekly of India (October 1983): 8-13.

Apte, D. P. "Role of Cooperative Dairy Development Schemes in Rural Development." Paper presented at the Symposium on Cooperatives and Rural Development, University of Montreal, Quebec, 1983 (mimeographed).

Asian and Pacific Center for Women and Development. "Impact on Women: The Anand Pattern of Dairy Development." In Section 5 of Women's Employment--Possibilities of Relevant Research. Anand, India: Research and Development Department, National Dairy Development Board, 1979.

Barzel, Yoram. "The Theory of Rationing by Waiting." Journal of Law and Economics 18 (1974): 73-95.

Baviskar, B. S. "Dairy Development in a Tribal Area of Gujarat." Institute of Social Studies, The Hague, 1984 (mimeographed).

_____. "Milk and Sugar: A Comparative Analysis of Cooperative Politics." Institute of Development Studies, Sussex, United Kingdom, 1984 (mimeographed).

_____. "Operation Flood and Social Science Research." Economic and Political Weekly (January 1984): 94-96.

Baviskar, B. S., and Attwood, Donald W. "Rural Cooperatives in India: A Comparative Analysis of Economic Survival and Social Impact." Paper presented at the Symposium on Cooperatives and Rural Development, University of Montreal, Quebec, 1983 (mimeographed).

Baviskar, B. S., and George, Shanti. "Operation Flood: A Different View." Economic and Political Weekly (November 1986): 161-162.

Beaton, George. "Energy in Human Nutrition: Perspective and Problems." Nutritional Review 4 (1983): 325-340.

Bhat, M. L. "Economic Survey of Borsod Taluka (Gujarat State) with Special Reference to the Impact of Community Development Program." Agroeconomic Research Center, Vallabh, Vidyanagar, India, 1966 (mimeographed).

Bowonder, B.; Dasgupta, B.; Gupta, S.; and Prasad, S. "Impact of Dairy Development Programs." Center for Energy, Environment and Technology, Administrative Staff College of India, Hyderabad, 1985 (mimeographed).

Brumby, Peter J., and Scholtens, R. G. "Management and Health Constraints for Small-Scale Dairy Production in Africa." Bulletin 25. Addis Ababa: International Livestock Centre for Africa, August 1986.

Casley, D. J., and Lury, D. A. Monitoring and Evaluation of Agriculture and Rural Development Projects. Baltimore: Johns Hopkins University Press, 1982.

Chatterjee, S. Aid, Trade, and Rural Development: A Review of New Zealand's Assistance to Indian Dairying. Working Paper on Dairy Development Series No. 3. The Hague: Institute of Social Studies, 1985.

Clay, Edward, and Mitchell, Mark. "European Community Food Aid in Dairy Products is Cost-Effective." European Review of Agricultural Economics 10 (1983): 97-121.

Crotty, Raymond. Cattle, Economics, and Development. Oxford: The Gresham Press, 1980.

_____. "Operation Flood and the EEC." Economic and Political Weekly (April 1983): 522.

Desai, D. K., and Patel, K. V. "Contribution of Dairying to Rural Economy with Special Reference to Small and Marginal Farmers." International Dairy Congress (1974): 64-75.

Desai, M. B., and Desai, M. D. New Strategy of Agricultural Development in Operation: A Case Study of the Kaira District in Gujarat. Research Study No. 15. Vallabh, Vidyanagar, India: Sardar Patel University, 1968.

Desai, M. B., and Varma, S. K. An Evaluation of Dairying Assistance Programme. Baroda, India: Department of Agricultural Economics, Faculty of Arts, University of Baroda, 1978.

Dogra, Bharat. "Not Such a Flood." Economic and Political Weekly (May 1982): 817.

_____. "The White Revolution: Who Gets the Cream?" The Economic Scene (No. 7, 1981): 10-19.

Doornbos, Martin; van Dorsten, Frank; Mishra, Manoshi; and Terhal, Piet. Operation Flood as a Food Strategy: Socioeconomic Implications and Issues for Research. Working Paper on Dairy Aid and Development Series No. 2. The Hague: Institute of Social Studies, 1985.

Doornbos, Martin, and Mitra, Manoshi. Politics of International Dairy Aid: International Interest and the White Revolution. Working Paper on Dairy Aid and Development Series No. 1. The Hague: Institute of Social Studies, 1985.

van Dorsten, Frank. The Rural Impact of Operation Flood: Viewpoints and Hypotheses. Working Paper on Dairy Aid and Development Series No. 4. The Hague: Institute of Social Studies, 1985.

European Communities Commission. "An Evaluation of the EEC Food Aid Programme," Brussels, June 1982.

_____. "Food Aid for Development," Commission Communication to the Council, Brussels, 1983.

Ezekiel, Hannan. "The Role of Dairy Food Aid in Economic and Social Development." International Food Policy Research Institute, Washington, D.C., March 1987 (mimeographed).

Food and Agriculture Organization of the United Nations. The Economic Impact of Dairy Development in Developing Countries. Rome: FAO, 1965.

Gadre, N. A., and Sapate, B. G. "Impact of Dairy Projects on Rural Economy: A Case Study." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 173.

Gangadharan, T. P., and Kumbhave, S. L. "Rationale of Fodder Subsidy: The Case of Kollengode Dairy Economy." Indian Journal of Agricultural Economics 37 (No. 3, July-September 1982): 260-265.

Garg, J. S., and Azad, M. P. "Economics of Crossbred Cow: A Case Study." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 149-150.

Garg, J. S., and Prasad, V. "An Economic Investigation into the Problems of Cooperative Milk Board, Kanpur." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 143.

George, P. S., and Srivastava, V. K. "Institutional Finance for Dairy Development." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 90-96.

George, Shanti. "Cooperatives and Indian Dairy Policy: More Anand than Pattern." In Cooperatives and Rural Development. Edited by Donald W. Attwood and B. S. Baviskar. Delhi: Oxford University Press, 1983.

_____. "Diffusing Anand: Implications of Establishing a Dairy Cooperative in a Village in Central Kerala." Economic and Political Weekly (December 1984): 2161-2169.

_____. "Faulty Lactometers - I: Village Level Evaluations of Operation Flood." Economic and Political Weekly (May 1986): 963-971.

_____. "Faulty Lactometers - II: World Food Programme, World Bank, and Jha Committee Evaluations of Operation Flood." Economic and Political Weekly (June 1986): 1020-1028.

_____. "Operation Flood and Rural India: Vested and Divested Interests." Economic and Political Weekly (December 1985): 2163-2170.

Gotsch, Carl H.; Ahmad, Bashir; Falcon, Walter; and Yusef, Shahid. "Linear Programming and Agricultural Policy: Micro Studies on the Pakistani Punjab." Food Research Institute Studies 14 (No. 1, 1975): 3-106.

Grewal, S. S., and Rangi, P. S. "Economics and Employment of Dairying in the Punjab." Indian Journal of Agricultural Economics 30 (No. 4, October-December 1980): 120-125.

Guha, H. "Operation Flood II, Some Constraints and Implications: A Comment." Economic and Political Weekly (April 1980).

Gupta, A. K. "Farmers' Response to Cooperative Project Implementation: Cases in Dairy and Pasture Development in Arid Regions." Ahmedabad, India: Center for Management in Agriculture, Indian Institute of Management, 1981.

Gupta, P. R., ed. Dairy India 1983. New Delhi: Rekha Printers, 1983.

_____. Dairy India 1985. New Delhi: Rekha Printers, 1985.

Halse, Michael. "Increasing the Incomes of Landless Laborers and Small Holders: The Experience of India's Dairy Cooperatives, Parts I and II." Agricultural Administration 15 (1980): 259-272.

_____. "Producing an Adequate National Diet in India: Issues Relating to Conversion Efficiency and Dairying." Agricultural Systems (No. 4, 1979): 239-278.

Huria, Vinod K., and Achaya, K. T. "Dairy Development in India: Some Critical Issues." Economic and Political Weekly (November 1980): 1931-1942.

India, Department of Statistics. National Sample Survey 28th Round (October 1973-June 1974), Report 240. New Delhi: Department of Statistics, 1977.

India, Ministry of Agriculture. Report of the Evaluation Committee on Operation Flood II. New Delhi: MOA, 1985.

India, National Commission on Agriculture. Interim Report of the National Commission on Agriculture on Milk Production through Small and Marginal Farmers and Agricultural Laborers. New Delhi: NCA, 1971.

Indian Dairy Corporation. Fifteenth Annual Report 1984-85. Gomdi-Anand, India: Anand Press, 1985.

Institute of Rural Management, Anand. "Profiles in Development: Operation Flood I at the Village Level: A Preliminary Summary of Results." IRMA, Anand, February 1981 (mimeographed).

Jain, Devaki. "Women, Food, and Technology: A Comment." Economic and Political Weekly (March 1980): 530-532.

Jodha, N. S. "Special Programs for the Rural Poor, the Constraining Network." Economic and Political Weekly (March 1973): 633-639.

John, P. Economics of Dairy Development in India. Digha Chat, Patna, India: Prabhat Prakashan, 1975.

Joshi, V. H. "Operation Flood and the Rural Poor." Institute of Development Studies, Sussex, United Kingdom, 1983 (mimeographed).

Jul, Mogens. "Comments on Operation Flood, 1985." Department of Food Preservation, Royal Veterinary and Agricultural University, Fredericksburg, Denmark, May 1986 (mimeographed), p. 26.

_____. "The Contribution of the Post-Harvest Food System to Employment Generation and Nutritional Improvement: Case Studies of the Potential of Dairy Technologies." Food and Nutrition Bulletin 7 (No. 2, June 1985): 14-20.

_____. "Unexpected Benefits from a Dairy Project." Food and Nutrition Bulletin 1 (No. 3, May 1979): 15-19.

_____. Personal communication, 1986.

Kahlon, A. S.; Dhawan, K. C.; and Gill, G. D. "Relative Profitability of Dairy Enterprise vis-a-vis Crop Cultivation in the Punjab." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 120-128.

Kalita, D. R., and Sharma, A. C. "Potentialities of Livestock Enterprises on Unirrigated Small Farms in the Gobardhana Block of Assam." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 164.

Kalyankar, S. P. "Economics of Milk Production by Different Breeds of Cows and Buffaloes." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 155.

Kataria, M. S. Geography of Indian Livestock and White Revolution. Kurukshetra, India: Vishal Publications, 1982.

Kumar, P.; Patel, R. K.; and Raut, K. C. "Lactationwise Production Function and Concentration in Milk Production for Haryana Cows." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 128-133.

Kumar, P., and Singh, R. P. "Dynamic Feed-Milk Relationship and Technological Change in Milk Production." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 126-132.

Kurien, V. A Black Lie. Gomdi-Anand, India: Anand Press, 1984.

Lele, Uma. "Cooperatives and the Poor: A Comparative Perspective." World Development 9 (1981): 55-72.

Lipton, Michael. "Indian Agricultural Development and African Food Strategies: A Role for the EC." In India and the EC. Edited by W. Caliewaert. Brussels: Center for European Policy Studies, 1985.

Mehta, Mira. "The Impact of Kheda District Milk Cooperatives on Protein Energy Malnutrition in Rural Indian Preschoolers." Ph.D. thesis, Cornell University, Ithaca, New York, 1981.

Mellor, John W. The New Economics of Growth. Ithaca, N.Y.: Cornell University Press, 1976.

Mellor, John W., and de Pontéves, Bruno. "Effect of Growth in Demand for Milk on the Demand for Concentrate Feeds in India, 1951-66." Indian Journal of Agricultural Economics 19 (1964): 131-146.

Mishra, G. P. "Impact of Dairy Development in Rural Areas of Karnataka." Institute for Social and Economic Change, Bangalore, India, 1980 (mimeographed).

Mitra, M. A Study of Women in Dairying in Andhra Pradesh. Report of a Baseline Survey. New Delhi: 1983.

Moore, M. P. "Some Microeconomic Aspects of the Livestock Economy." Indian Journal of Agricultural Economics 33 (No. 1, January-March 1978): 67-76.

Murty, K. N. Consumption and Nutrition Patterns of ICRISAT Mandate Crops in India. Economic Program Progress Report No. 3. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 1983.

Nair, K. Narayanan. "Operation Flood: Some Constraints and Implications: A Comment." Economic and Political Weekly (February 1980): 446-448.

_____. "Technological Change in Milk Production: A Review of Some Critical Issues with Reference to South Asia." Economic and Political Weekly (March 1982): A15-20.

_____. "White Revolution in India: Facts and Issues." Economic and Political Weekly (June 1985): A89-95.

Nair, K. Narayanan, and Jackson, M. G. "Alternatives to Operation Flood II Strategy." Economic and Political Weekly (December 1981): 2129-2132.

National Bank for Agriculture and Rural Development. Dairy Development Schemes in Western Uttar Pradesh (An Ex-Post Evaluation Study). Bombay: NABARD, Economic Analysis and Publications Department, 1982.

National Dairy Development Board. Annual Report, various issues. Anand, India: NDDB, various years.

_____. Breeding and Feeding for Milk Production in Operation Flood II. Anand, India: NDDB, 1980.

_____. "Nutritional Impact of Operation Flood." Indian Dairy Corporation, Anand, India, 1983 (mimeographed).

_____. Operation Flood: A Proposal. Anand, India: NDDB, 1977.

_____. "Proceedings of the National Conference on Cross-Breeding." Anand, India: NDDB, 1978.

National Nutrition Monitoring Bureau. "Food and Nutrient Consumption Patterns in the Selected Districts of Different States - 1980." National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 1981 (mimeographed).

Nyholm, Klaus; Schaumberg-Muller, Henrik; and Westergard, Kirsten. "Socioeconomic Aspects of Dairy Development, Report from the Bangalore Milkshed Area." Economic and Political Weekly (December 1974): A127-136.

Pandey, R. N., and Bhogal, T. S. "Prospects of Increasing Income and Employment on Mixed Farms." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 141-154.

Patel, A. S. "Cooperative Dairying and Rural Development: A Case Study of Amul." Paper presented at the Symposium on Cooperative and Rural Development, University of Montreal, Quebec, 1983 (mimeographed).

Patel, A. S., and Jodha, N. S. Economic Relationship Between Crop Farming and Dairying in a Developing Area: A PL-480 Micro Level Study of South Gujarat. Gujarat, India: Agroeconomic Research Center, Sardar Patel University, 1979.

Patel, R. K. "Rapporteur's Report on Economics of Livestock Enterprises with Special Reference to Its Employment Potential." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 174-190.

Patel, R. K.; Singh, Raj Vir; Saini, Amrik S.; and Nagpal, R. C. "Energy Input and Cost of Milk Production." Agricultural Situation in India (February 1982): 791-795.

Patel, S. "The 'Anand' Pattern: A Socio-Historical Analysis of its Origin and Growth." Paper submitted to the IDPAD Project of the Institute of Social Studies, The Hague, 1984 (mimeographed).

Patel, S. M., and Pandey, M. K. Economic Impact of Kaira District Cooperative Milk Producers Union (Amul Dairy) in Rural Areas of Kaira District (Gujarat State). Ahmedabad: Institute of Cooperative Management, 1976.

Pinstrup-Andersen, Per. "Decisionmaking on Food and Agricultural Research Policy: The Distribution of Benefits from New Agricultural Technology Among Consumer Income Strata." Agricultural Administration 12 (No. 1, 1977): 13-28.

_____. "The Impact of Export Crop Production on Human Nutrition." In Nutrition and Development. Edited by Margaret Biswas and Per Pinstrup-Andersen. London: Oxford University Press, 1985.

Pinstrup-Andersen, Per; de Londono, Norha R.; and Hoover, Edward. "The Impact of Increasing Food Supply on Human Nutrition: Implications for Commodity Priorities in Agricultural Research and Policy." American Journal of Agricultural Economics 58 (No. 2, May 1976): 131-142.

Pitt, Mark. "Food Preferences and Nutrition in Rural Bangladesh." Review of Economics and Statistics 65 (No. 1, 1983): 105-114.

Radhakrishna, R., and Murty, K. N. Models of Complete Expenditure Systems for India. Laxenburg, Austria: International Institute of Applied Systems Analysis, 1980.

Radhakrishnan, S. A., and Sivanandham, M. "Dairying as a Subsidiary Enterprise in Farms--A Micro Level Analysis." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 159.

Rajapurohit, A. R. "Bovine Feed Availability and Requirements in Karnataka with Reference to Dairy Development Programmes." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 111-120.

_____. "Cross Breeding of Indian Cattle: An Evaluation." Economic and Political Weekly (March 1979): A9-24.

Ratnam, C. "Short-Run Supply Functions of Milk: A Note." Indian Journal of Agricultural Economics 38 (No. 4, October-December 1982): 517-520.

Raut, K. C.; Singh, Shivtar; and Rustogi, R. L. "Comparative Economics of Rearing Cross-Bred and Non-Descript Calves under Village Conditions." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 139-144.

Rossi, P. H.; Freeman, H. E.; and Wright, S. R. Evaluation: A Systematic Approach (Beverly Hills, Cal.: Sage Publications, 1979).

Ryan, James; Sheldrake, A.; and Yadev, S. Human Nutritional Needs and Crop Breeding Objectives in the Semi-Arid Tropics. Economics Program Occasional Paper 7. Hyderabad, India: International Crops Research Institute for the Semi-Arid Tropics, 1974.

Saini, A. G. "Impact of Dairy Enterprises on Farm Incomes in Punjab." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 159.

Sambrani, Shreekant. "Managing Commodity Systems: The Development of Cooperative Dairying in India." Agricultural Administration 11 (No. 4, 1982): 259-271.

Sankhayan, P. L., and Joshi, A. S. "Resource Productivity in Milk Production of Crossbred and Indigenous Cows in Rural Areas of Ludhiana District (Punjab)." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 105-111.

Selowsky, Marcelo. "Target Group-Oriented Food Programs: Cost-Effectiveness Comparisons." American Journal of Agricultural Economics 61 (No. 5, December 1979): 988-994.

Shah, Dilip. "An Estimate of Employment and Income Benefits Generated by Amul Dairy." Anvesak 11 (Nos. 1-2, June-December 1981): 281-302.

_____. "Production Functions in Cooperative Dairy Industry of Gujarat." Indian Journal of Industrial Relations 17 (No. 3, 1982): 395-408.

Shah, Tushaar. "Economic Impact of Operation Flood: Report on a Detailed Survey of Six Villages." Institute of Rural Management, Anand, India, 1983 (mimeographed).

_____. "Producer Behaviour Market Structure and Technology in Indian Dairy Industry: Some Managerial Implications." Agricultural Systems 2 (1983): 41-64.

Shah, Tushaar; Tripathi, A. K.; and Desai, Maulik. "Impact of Increased Dairy Productivity on Farmers' Use of Feedstuffs." Economic and Political Weekly (August 1980): 1407-1412.

Sharma, R. K. Book Review of "Cattle, Economics, and Development," by R. Crotty. Indian Journal of Agricultural Economics 36 (No. 2, April-June 1981): 72-74.

Sidhu, D. S. "Rapporteur's Report on Dairy Development and the Bovine Economy." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 161-171.

Singh, A., and Singh, R. V. "Impact of Dairy Enterprises on Productivity and Employment." Agricultural Situation in India 32 (No. 3, June 1977): 139-142.

Singh, Baldev. "Economics of Milk Production and Bovine Livestock Compositions in a Growing Economy." Indian Journal of Agricultural Economics 34 (No. 2, April-June 1979): 61-70.

Singh, C. B.; Dhaka, J. P.; and Sharma, S. P. "Labor Absorption and Factors Influencing Levels of Employment in Crop, Dairy, and Poultry Enterprises." Indian Journal of Agricultural Economics 36 (No. 4, October-December 1981): 14-20.

Singh, Katar, and Das, V. Mukunda. "Impact of Operation Flood I at the Village Level." Institute of Rural Management, Anand, India, 1982 (mimeographed).

Singh, N.; Jain, D.; and Chand, M. "Milkmaids of Kaira District: Some Notes." Institute of Social Studies, New Delhi, 1979 (mimeographed).

Singh, Parmatma, and Jha, Dayanatha. "Economic Options in Milk Production." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 96-105.

Singh, S. P., and Kelley, Paul. AMUL: An Experiment in Rural Economic Development. New Delhi, India: Macmillan, 1981.

Singh, Surendar. "Operation Flood II: Some Constraints and Implications." Economic and Political Weekly (October 1979): 1765-1774.

Singh, Surendar, and Sharma, R. K. "Some Implications of Area Choice in the Operation Flood II Programme." Economic and Political Weekly (March 1981): A15-28.

Singh, Surendar, and Singh, Kamaljit. "Import of Donated Commodities, Export of Feed; and New Technology of Milk Production." Economic and Political Weekly (July 1985): 1227-1235.

Sirohi, A. S.; Sharma, B. M.; Singh, Ikbal; and Dayal, Rameshwar. "Role of Dairy-Poultry Enterprises for Increasing Income and Employment on Farms in the Union Territory of Delhi." Indian Journal of Agricultural Economics 35 (No. 4, October-December 1980): 112-119.

Sivaraman, B. "Cross-Breeding in Cattle." Paper presented at national conference on cross-breeding, National Dairy Development Board, Anand, India, 1978.

Somjee, A. H. "The Techno-Managerial and Politico-Managerial Classes in a Milk Cooperative of India." Journal of Asian and African Studies 17 (Nos. 1 and 2, 1982): 121-135.

Somjee, A. H., and Somjee, Geeta. "Cooperative Dairying and the Profiles of Social Change in India." Economic Development and Cultural Change (1978): 577-590.

Sukhatme, P. V. "Incidence of Protein Deficiency in Relation to Different Diets in India." British Journal of Nutrition 24 (1970): 447-487.

Sundaresan, D. "Buffalo: India's Milk Machine." In Dairy India 1985. Edited by P. R. Gupta. New Delhi: Rekha Printers, 1985.

Terhal, Piet, and Doornbos, Martin. "Operation Flood: Development and Commercialization." Food Policy 8 (August 1983): 235-239.

Thakur, D. S. "Impact of Dairy Development through Milk Cooperatives: A Case Study of Gujarat." Indian Journal of Agricultural Economics 30 (No. 3, July-September 1975): 83-96.

Vaidyanathan, A. "Aspects of India's Bovine Economy: Some Preliminary Results." Indian Journal of Agricultural Economics 33 (No. 1, January-March 1978): 1-30.

Vaishnav, T. N. "Cross-Breeding Program in Cattle - Limitations in DDAP and Tribal Areas." Paper presented at national conference on cross-breeding, National Dairy Development Board, Anand, India, 1978.

Verma, R. C., and Pant, D. C. "Potentialities of Increasing Farmer Income and Employment Through Dairying." Indian Journal of Agricultural Economics 33 (No. 3, July-September 1978): 83-93.

Vyas, V. S., and Choudhary, K. M. "Economics of Dairy Farming in Mehsana District." Artha-Vikas 7 (No. 2, July 1971): 20-40.

World Bank. India: National Dairy Development Project. Staff Appraisal Report. Washington, D.C.: World Bank, May 1978.

World Food Programme. Detailed Report of the Second World Food Program Evaluation Mission on Operation Flood. New Delhi: Indian Dairy Corporation, 1976.

_____. Terminal Evaluation Report on Project India 618--Milk Marketing and Dairy Development, Operation Flood I. New Delhi: World Food Programme, September 1981.

Harold Alderman is a research fellow at the International Food Policy Research Institute; George Mergos is a research associate at the Centre of Planning and Economic Research, Athens; and Roger Slade is a senior economist at the World Bank.