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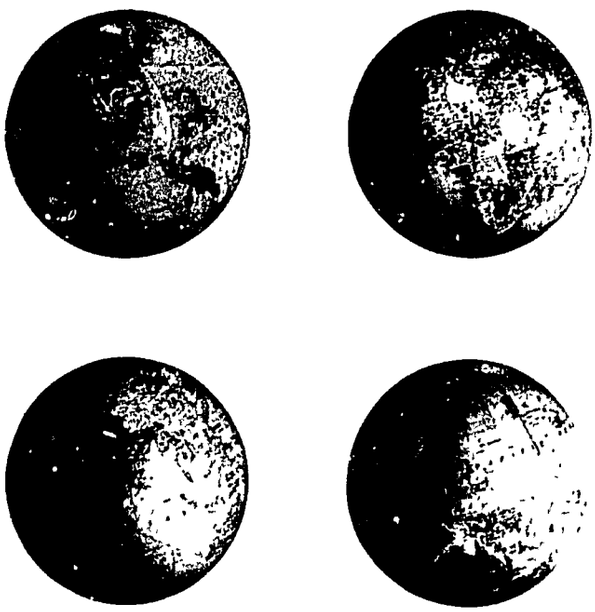

THE MODERNIZATION DECISION IN INDIAN URBAN FLUID-MILK MARKETS

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NEW YORK STATE COLLEGE OF AGRICULTURE
A STATUTORY COLLEGE OF THE STATE UNIVERSITY
AT CORNELL UNIVERSITY, ITHACA, NEW YORK

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Preface

Economic development brings rising incomes and a consequent major change in the pattern of demand for agricultural commodities. Luxury type agricultural commodities for which demand grows, tend to be bulky, perishable commodities with particularly difficult marketing problems. If these marketing problems are not solved, higher prices will turn consumption to other commodities, rather than stimulating high production. The opportunity for using underemployed resources in the production of increased national income will be lost. This is particularly true of labor in the agricultural sector. As consumption turns in other directions it is possible that a greater burden will be placed on scarce foreign exchange resources. Their use is then diverted toward consumption and away from capital goods which can contribute to longer-term, more rapid processes of growth.

The demand for milk in India grows rapidly with rising incomes. Increased milk production gives opportunity for considerable additional employment in rural areas. The marketing problems for milk, however, are very difficult because of the bulkiness and perishability of the product and because there has been relatively little past experience and research in the marketing of this commodity. The importance of this problem is recognized in India and there has been considerable expenditure on marketing programs and inquiry into their success.

This research analyzes the traditional marketing system for milk in the area near New Delhi and the performance of a set of modern milk plants in various cities in India, while comparing the performance of the two systems. In dealing specifically with the question of the marketing of milk, this study helps to clarify the important question of the choice of technology in the context of economic development. The author delineates the dissimilar functions and roles of the traditional system and the modern system. Knowledge of their unique input characteristics provides understanding as to how substantially different technologies may survive simultaneously and may complement each other in contributing to total processes of growth and development. A number of important recommendations relevant to current policy are presented. In this pioneering study a great many more questions which require additional research are raised.

Information for this work was obtained by collecting accounting data from modern milk plants in India, intensively surveying the traditional marketing system near New Delhi, and interviewing many people associated with milk marketing in India. Despite the many immediate policy pressures on their time, officials and administrators in public, private, and cooperative sectors took considerable time to direct this study into the most useful and productive areas of research. The result of these efforts is an important introductory investigation into the problems of marketing milk in India and into the general question of choice of technology in the processes of modernization.

The study of milk marketing in the Indian economy is one of a series being conducted at Cornell University as part of a USAID-financed contract for research on agricultural prices. We are grateful for the assistance provided by the Agricultural and Rural Development Service of the War on Hunger of USAID and, in particular, to Douglas Caton and Norman Ward.

The broad program of research, of which this study is one part, covers 3 major areas of inquiry: (1) the role of prices in intersectoral income and capital transfers; (2) the effect of price relationships on agricultural production and marketings and; (3) the factors affecting urban prices of agricultural commodities. These studies are concerned with the affects of agricultural prices on the nonagricultural sectors of the economy, with their affects in the agricultural sector, and with the manner in which agricultural prices are determined. A substantial number of studies are being carried on in several countries dealing with various aspects of the processes. Upon completion of these studies an effort will be made to pull them together into an integrated view of the role and functioning of agricultural prices in the developmental process.

A basic objective of the contract with USAID for the conduct of this research is not only to produce useful research results, but also to provide structured research experience, thus enlarging our pool of trained manpower for the analysis of such problems. For this purpose the research in this project is accomplished primarily through the use of Ph.D. candidates at Cornell University, who use the specific studies conducted as Ph.D. dissertations. Definition of the overall project has purposefully been kept broad and flexible to facilitate the attainment of this additional objective. This study is part of that program and is drawn from the Ph.D. dissertation of Ray W. Nightingale, of the same title as this monograph, completed at Cornell University in 1968.

John W. Mellor

Chapter 1.

Introduction

In the early stages of economic development, food items are dominant in the consumption expenditures of a high proportion of families. In such families, increases in income cause substantial changes in food consumption habits, including sharp increases in the demand for certain foods. Food preferences revealed by income changes reflect a variety of consumer needs. Among these are nutritional improvement, variety in the diet, social status, and relief from the labor or nuisance of household tasks.

To the Indian consumer, milk and products derived from milk are decidedly superior foods providing nutritional improvement and enhancing social status. Estimates of the income elasticity of demand for milk and milk products in India range from .8 to 1.5 (20, p. 16; 22, p. 102).

Both population growth and rising income are contributing to a rapid expansion in the demand for milk. Aggregate 1970–71 demand for milk and milk products in India has been projected at 47.6 million long tons as against an estimated 1955–56 consumption of 19.3 million. Projected 1975–76 demand, at 68.8 million tons, is twice 1965–66 consumption (20, p. 15; 21, p. 134).

The demand result of population growth and rising income is substantially greater in urban than in rural areas. Increase in population between 1951 and 1961 in cities of over 100,000 population is estimated between 40 and 50 percent (10, pp. 24–26), more than twice the percentage increase for the nation as a whole. The rate of increase in the per capita level of income in growing cities is comparatively high, further accelerating the demand for milk.

Rapid growth in the demand for milk and milk products has placed a heavy burden on the traditional system of producing and marketing milk. Population increases and an inadequate rate of growth in general agricultural productivity have resulted in the retention of a large share of agricultural resources in the production of basic food grain requirements. Consequently, increased demand for milk has resulted in rapid price increases and restricted levels of consumption, particularly among middle and low income urban groups.

Estimates of daily national per capita consumption of milk in all forms in India range from 4.5 to 6 ounces (20, p. 12). Substantial variation exists in consumption among income groups. National Sample Survey (NSS) data

reveal that at the lower income levels, milk consumption in urban areas is almost nil (9, p. 101). Per capita milk consumption by industrial level wage earners is 2 or 3 ounces per day. The typical industrial worker spends 6 percent of his earnings to achieve even this level of consumption. For the great majority of the urban population milk is a luxury food to be consumed either in small quantities by a few members of the household, or in larger quantities on festival occasions.

Milk production for urban fluid consumption has been confined largely to urban or suburban areas. This is the result of the perishability of milk distributed through traditional marketing systems. In suburban areas milk production is predominantly a subsidiary enterprise utilizing by-products of crop production. Increases in supply are achieved through adjustments in livestock management practices and expanded use of purchased inputs. Growth in the marketing of fodder, concentrates, and livestock has contributed to increased milk supplies.

Broadening the fluid milkshed to permit extensive expansion of production requires a technical capability and capital investment which cannot be achieved within traditional milk marketing systems. The low rate of technical advance in traditional fluid-milk markets has inspired a public sector program of modernization in urban fluid-milk markets, seeking to achieve short run gains in the level of urban milk consumption. Indian economic planners and international agencies engaged in promoting milk consumption in India have felt that traditional marketing systems were a major impediment to expanded consumption and that greater opportunities existed for productive innovation in marketing rather than in the milk production enterprise.

During the last decade, entirely new systems of fluid-milk marketing have been established in numerous Indian cities, using modern milk processing systems and transportation equipment. The modern capital intensive system is superimposed upon traditional labor intensive systems through which the greater part of the urban milk supply still flows. Thus, the two systems compete directly to provide a link of market services between the rural milk producing household and the urban consumers. The major advantages of the modern system are its capacity to expand the dimensions of the milkshed and its improvement of product quality. These advantages can be negated by high costs or by failures to respond to specific service demands of the market.

The objectives of this study are: (1) to identify problems in Indian dairy market development, and (2) to assess the performance of the recently established modern system in meeting these problems and in hastening development in the dairy livestock economy.

The basic approach to research on the modernization process in fluid-milk marketing is the in-depth analysis of marketing costs in the traditional vs. the modernized sector. A major issue on the minds of managers of the public sector fluid-milk distribution systems is the competition they face from traditional milk sellers. This competitiveness is not attributed to marketing

costs but rather to malpractices in the traditional system, such as adulteration, and to the presence of milch animals within the cities.

Controversy over the presence of the competitive traditional milk market makes research on this system of interest to those responsible for implementing and operating the modern systems. Also, many of the milk-procurement systems of government-operated milk processing plants are linked to traditional systems. Village residents procure milk and deliver it to points accessible to motorized vehicles. The institutional relationship between this initial marketing agent and milk producing households may be of a cooperative type or it may be identical to the traditional trader.

Traditional and modern milk marketing systems of India are viewed, for the purpose of this study, as concurrent systems offering distinctly different forms of consumer and producer services. Chapter 2 describes the salient features of the Indian Dairy Economy. Chapter 3 is a case study of the most dynamic of the traditional milk marketing systems, the *cycle-dudhia*. It serves as a model by which to gauge the comparative advantage of the modern system. Chapter 4 surveys the modern, capital-intensive fluid-milk distribution system. Chapter 5 treats the problem of transition in the assignment of functions to the traditional and modern system as modernization progresses and the identification of existing maladjustments based on economically irrational functional assignments.

Chapter 2.

Salient Features of the Indian Dairy Economy

All elements of the "mixed economy" are in evidence in Indian dairy markets. The emergence of public sector enterprises in fluid-milk distribution is the focal point of this study. Cooperatively owned fluid-milk distribution systems operate in several Indian cities. Private, public, and cooperative enterprises manufacture and distribute milk products. Although a few private firms operate relatively modern fluid-milk plants, the traditional small-scale milk seller is dominant in the private sector.

No administered prices and no quantitative or geographic restrictions were imposed in 1966-67 by the central government in traditional milk and milk product markets. Although there may be instances in fluid-milk markets where individual sellers do influence price, these would be exceptions to the general competitive circumstances in traditional markets. The volume of sales by individual sellers is small. Because of the low per capita consumption, a large number of consumers are served by each seller. Residential areas are densely populated and numerous marketing agents operate within

a confined area. Fluid milk may be available through different but competing traditional marketing systems. The relatively homogeneous nature of the milk product and its perishability further suggests that markets are competitive.

Because fluid milk is perishable, marketing agents who rely on rural sources of milk supply make use of a variety of techniques of transportation and devise ways of insuring control over product quality. The essential skills are not difficult to acquire and technology is rudimentary; capital investment requirements are accordingly small.

It has been estimated that 20 percent of Indian milk production takes place in urban areas, 10 percent in nearby villages, and the balance in rural areas (20, p. 9). The milk production enterprise in rural India differs substantially from dairy farms in the United States or western Europe. The size of the village household is large, relative to the volume of milk produced. The primary enterprise in crop production is food grain rather than fodder and livestock feed grains. Land holdings are small. The opportunity cost of household labor is low.

The quantities of milk which the Indian peasant will choose to market is a consequence of both production possibilities and consumption preferences. Food consumption patterns of milk producing households in India are basically different from those of countries in the temperate zone. Milk is commonly the only source of animal protein in the diet of the villager. Other animal protein sources are available; however, the farmer is prohibited from using them both by his own food prejudices and by his social position. His general access to consumer goods is limited. Thus, the list of goods which are competing for his earnings is low. As his production and sales of milk increase, it is probable that the volume of household milk consumption will also increase considerably.

Certain attributes of milk cause the production enterprise to be strongly influenced by location. One component of whole milk, butterfat, is easily isolated from the whole-milk solution. Thus, in every dairy economy, milk is the source of two different food ingredients. In India, milkfat is commonly converted to *ghee,* a product which can be stored for long periods of time (8, p. 67). Relative bulk and perishability of whole milk compared to ghee cause supply areas to be sharply differentiated. The boundary in traditional Indian fluid-milk markets is set by the maximum distance which milk can be transported without souring, rather than by transportation charges. Beyond this point the returns to milk production drop sharply as producing households turn to ghee selling.

Indian dairy bovines, feeding practices, climatic environment, and institutional setting of the milk production enterprise are greatly different from that generally observed in western countries.[1] Cattle of India have for cen-

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[1] The term bovine refers to both the Indian cattle (*Bos Indicus*) and the water buffalo (*Bos bubalis*).

turies been bred primarily as draft animals. While milk production capability was not neglected, it was given secondary consideration. Desired draft characteristics were related to milk production capability and breeds of draft cattle such, as the Hariana, are also among the better milk producers (27, p. 18).

In some parts of India, particularly the west and northwest, the water buffalo has been bred specifically as a dairy animal. The Murrah breed found in northwest India and the Mehsana breed in Gujarat State are typical of the dairy buffalo (38, p. 165). The dairy buffalo is a major source of urban milk production in northern India and the three largest cities of Bombay, Calcutta, and Delhi (38, p. 161).

The 1961 bovine census in India was 227 million. Only 75 million of these were females kept for breeding purposes. One-third of this 75 million were buffaloes. One-half of the buffalo were in milk in contrast to two-fifths of the cattle. Approximately one-half of estimated milk produced was buffalo milk (20).

Government of India dairy development program

The central government of India has been the major source of innovation in Indian urban fluid-milk markets. Modernization is striking in its absence among individual entrepreneurs providing fluid milk to the larger urban community. Markets have changed little in equipment used and services offered since the 1940's.

Private firms operated a number of small milk bottling plants in several Indian cities in 1967. These small plants, built before or just after independence, catered to higher income communities and could not compete at price levels set by the public sector. Older private plants did not attempt to serve lower income groups. Some had turned to selling flavored milk and ice cream through sidewalk vendors. Generally, a community of higher income people who did not have access to milk from the public sector dairies patronized the small private dairy.

Although the traditional trader in milk and milk products has shown little inclination to innovate, an entirely modern dairy processing system has developed in India. Several groups, each with distinctly separate objectives, have been responsible for this development.

The central government, with the assistance of various national and international agencies, has implemented a nation-wide program to establish modern fluid-milk bottling plants in urban centers. By 1967, approximately 27 fluid-milk bottling plants were owned and operated by governmental bodies. About 13 cooperative fluid-milk plants were operating. Two milk product plants were also supplying bulk pasteurized milk to urban bottling plants. Initial capital for cooperative operations generally was provided either through government grants and loans or by international assistance

channeled through government agencies. The more successful cooperatives also had made major investments from their own resources.

The dairy cooperative in India is diverse in its organizational structure and in its links to the public sector. Many government assisted cooperatives make their debut in fluid-milk marketing and are immediately faced with the severe competition of the private traditional system, but lack the financial backing of the public sector. Even if management is so inclined, it has little resources for product development. Recourse to public-sector financial support results in a mixing of goals and objectives which make effective management difficult.

Private sector modernization has been confined almost exclusively to the manufacture of dairy products. Private-sector dairy products manufacturing was carried on in 1967 by several Indian subsidiaries of private international firms. Modern processing and packaging equipment was also employed by a number of Indian ghee and butter packers.

In addition to the approximately 57 modern dairy plants which had been fully implemented as of the first quarter of 1967, approximately 19 "pilot projects" were under way. The pilot projects are experimental programs initiated by the public and cooperative sector to test the feasibility of introducing milk processing plants. The primary objective is to establish a milk procurement and distribution network. This is initially a raw milk operation, but may move to pasteurized bulk distribution, and finally to a bottling plant. The time needed to move from initial motorization of procurement to a full plant is highly variable. Some of the pilot projects have considerable permanency.

Proposed Fourth Five Year Plan expenditure on dairy marketing and animal husbandry was twice that of the Third Plan period. Investment in the dairy industry was encouraged in future development plans (2, p. 599).

Concern with consumer welfare dominated dairy development planning in India during the second and third Five Year Plans (1956–66). Proposals for dairy development during the Fourth Plan similarly reflect concern for insuring the availability of milk to all communities. This concern is accompanied, however, by greater emphasis on achieving productivity gains in milk production (12, pp. 9–10).

Some shift in emphasis by the dairy planners may be reflected in specific plans for the establishment of plants during the Fourth Plan period. New facilities will have a capacity of 6 to 10 thousand liters per day. This is largely a consequence, however, of smaller urban localities to be served. Fourth Five Year Plan proposals include the establishment of 70 new fluid plants and 26 product plants by 1971 (14, p. 203).

Successful implementation of market modernization programs necessitates the identification and solution of many specific problems. The four principal problem areas in Indian urban fluid-milk markets are: (a) consumption habits and preferences, (b) the milk production enterprise, (c) the traditional marketing system, and (d) market modernization programs.

Consumption habits and preferences

About 40 percent of milk produced in India is consumed in liquid form. Forty-six percent is utilized in ghee and butter making and the balance goes to other dairy products, principally *dahi* (9 percent) and *khoa* (4 percent). Butter and ghee making yield skimmed milk and *lassi*. These by-products contribute substantially to the consumption of rural non-fat milk solids (2, 30, 32).

Whole milk is customarily boiled and drunk while hot in the urban household. Frequently, sugar is added. This practice is carried on regardless of the source or quality of the milk. Liquid milk is not generally drunk by infants. It is used whole by children and to some extent by adults. The major liquid-milk consumption by adults is in tea or coffee most often in restaurants, rather than in the household.

Substantial milk consumption, particularly by adults, is in the form of a variety of processed milk products, the result of efforts to preserve milk under Indian climatic conditions (32). Although some of the traditional products are familiar to western consumers, some are unknown, and others are not customarily consumed.

Ghee is the traditional cooking medium used. It is also an ingredient in many prepared foods and is used as a spread for a variety of oven-baked unleavened breads.

In India, as in the U.S., vegetable fat can be substituted for butterfat in many uses. NSS consumption surveys indicate per capita expenditure on *vanaspati* (hydrogenated vegetable oil) by residents of large cities to be one-third the expenditure on ghee and butter; it is much lower in rural areas. Vanaspati costs about one-half as much as ghee in urban markets (11).

Khoa is used primarily as a base for confections. Made from whole milk. Khoa adds substantially to the nutritive value of these highly favored sweets. It is manufactured by boiling whole milk until the moisture content is down to about 25 percent. A good quality product processed by the traditional method requires considerable labor by an attentive individual.

The traditional rennet coagulated cheeses are not widely manufactured. *channa,* a lactic coagulated product, is consumed widely in the eastern part of India; it is also used as a base in confectionaries.

Much of the manufacture of milk products takes place in the consumer's household. Traditional methods of preparing these products are laborious, requiring constant attention throughout the process (32). Products, other than ghee, are not generally manufactured in the rural areas for urban sale. They are commercially prepared in urban shops.

The traditional dairy products of India are peculiar to that society; processing and packaging techniques developed in western dairy markets are often not applicable.

Per capita consumption of milk and milk products

Low per capita consumption levels in milk markets result in severe distribution problems. Small quantities of the high priced, perishable product must be delivered to a large number of consumers.

In the 1957–58 NSS Consumption Expenditure Survey, expenditure on liquid milk represented 8 percent of total food expenditure and 5 percent of total expenditure by all urban households. In the larger cities, 11 percent of total food expenditure was for liquid milk. The monthly expenditure per household was Rs. 5.59 in urban areas and Rs. 9.50 in the larger cities. In 1957–58, urban milk prices were Rs. 0.50 to Rs. 0.80 per liter.[2] Daily household consumption was, therefore, slightly over one third of a liter (10 oz.) in all urban areas including the larger cities. Per capita consumption of liquid milk was 2.4 oz. for all urban areas and 3.1 oz. for large cities.

If a home delivery milk distribution system were to be established to serve all income groups, the delivery per household trip would be one-sixth of a liter. Even if the service were confined to households with more than 300 rupees income per month, the delivery to each household would be three-quarters of a liter to one liter. Such small quantities of sale per purchaser increase distribution cost and the possibility of milk spoilage.

The foregoing are only approximations of per capita and per household expenditure on liquid milk. Neither the price data nor the consumer expenditure data are accurate because of the prevalence of dilution. The practice of dilution is so common that consumers are accustomed to it (6, p. 14).

Per capita expenditure on milk and milk products combined is 2 to 3 times as high in urban areas as in rural. Estimates of per capita consumption by individual states reflect the substantial regional differences in the quality of resources available for milk production (table 1). As these estimates are for consumption in all forms, they are not comparable with urban estimates of fluid-milk consumption. The estimates suggest, however, that the extent of the distribution problem posed by low per capita consumption varies among regions.

Effect of income distribution on the level and form of milk consumption

Foods which are highly income elastic move into the households of higher income families as incomes rise. This may bring into conflict the objective of servicing the demands of well-to-do people and the welfare objective of meeting the nutritional problems of the poor.

Studies of consumption expenditure consistently indicate that Indians substantially increase consumption of milk and milk products as their level of income rises (20, p. 15: 22, p. 102). Expenditure elasticities for milk and milk products computed over 9 rounds of the National Sample Survey

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[2] Price estimates are based on quotations for Delhi, 1957–58, and the 1963 interurban price structure in large and medium-sized cities (11, 13).

Table 1. **Per capita consumption of milk and milk products, by states, India (1956)***

State	Daily per capita consumption (milk equivalent)	Total production
	ounces	thousand metric tons
Punjab†	13.3	2,441
Uttar Pradesh	7.4	5,350
Rajasthan	7.3	1,334
Himachal Pradesh	7.0	88
Andhra Pradesh	5.5	1,970
Bihar	4.9	2,157
Madhya Pradesh	4.4	1,300
Delhi‡	3.9	77
Mysore	3.4	745
Bombay§	3.2	1,764
Andaman and Nicobar	3.1	1
Jammu and Kashmir	2.7	137
Tripura	2.6	19
Madras	2.4	832
West Bengal	2.4	719
Orissa	1.7	277
Kerala	1.3	203
Assam	1.2	127
Manipur	0.7	5
All India	4.8	19,545

Source: Alternative projections of the supply and demand for milk in India and their influence on demand for concentrate feeds, 1951–1976 (29, p. 29).

* The source of these data is the Directorate of Marketing and Inspection. Original per capita consumption estimates were based on 1956 milk production estimates and 1951 population data. These have been adjusted by Ponteves to account for 1951–56 population increase.

† Parts of this state now lie in Punjab, Haryana, and Himachal Pradesh.

‡ As per capita production is used as a proxy for consumption, Delhi consumption is under-stated due to imports. This source of error is probably not significant for other areas.

§ The present states of Gujarat and Maharashtra were formed in 1956 from the former Bombay State.

averaged 1.85 for rural areas and 1.78 for urban areas, implying income elasticities of 1.55 (urban) and 1.49 (rural).[3]

Published findings of the 13th round of the NSS give a more detailed breakdown of consumer expenditures on milk and milk products than earlier rounds. Data are published by household expenditure levels rather than by per capita expenditure classes. These data indicate the effect of rising in-

[3] For a study providing somewhat lower elasticities, see (22).

come on milk and milk-products consumption to be basically similar in urban and rural areas. This suggests a continued high income elasticity of demand for milk and milk products among higher income groups. Comparison of cash purchases of milk and milk products and the value of consumption indicate substantial quantities of milk are produced by urban households having high incomes.

Generally, the proportion of expenditure on ghee and butter rises with increased income and is higher among the rural population than it is in urban areas. This may reflect the increasing use of vanaspati by urban residents.

Milk production enterprise

Milk and milk-products are relatively costly foods in all agricultural economies. This is a consequence of the combining of crop and animal production processes. Costly milk production may reflect inefficient or low yield production processes and results in price levels which restrict consumption in low income communities. Rapid increase in urban milk prices suggests a relatively inelastic supply situation of milk to urban consumers. In some larger cities, buffalo milk prices have recently been increasing annually by 8 to 16 percent per year (11). Price increases in cities located in superior dairy regions have not been quite as large.[4] In major urban centers, or in cities where buffalo milk production is predominant, the trend in ghee prices has been parallel to milk prices. In Madras and Bangalore, however, ghee prices have been rising more rapidly because demand is not being met by cows in the area.

Published findings of the IARS indicate that buffalo milk production is cheaper in rural and suburban areas while in urban areas the cost of producing cow's milk is less than or on a par with the cost of buffalo milk. Panse, *et al.* (26, p. 5) conclude that the superior performance of urban cows is due to higher milk yields. The better animals are maintained in urban areas and dry animals are moved to rural areas. Considerable commerce in bovines occurs between urban and rural areas. Higher urban depreciation charges reflect rural maintenance of dry or nearly dry bovines (24, 25, 26, 27). The practice of maintaining dry and nearly dry animals in rural areas may result in either low average annual depreciation or appreciation in these areas. This supply of milch stock is depreciated in the urban market.

While the proportion of expenditure for feed costs is not highly variable between cows and buffaloes the components of feed differ. In the Punjab, a region endowed with agricultural resources and livestock, the milking buffalo consumes comparatively large quantities of dry fodder and concentrates during the summer season, reflecting its relative advantage in situations of green fodder shortages (26). In the rainy season when green fodder is available,

[4] Comparative prices for cow's milk are not available.

substantially larger quantities are consumed by buffalo. Improved feeding indicates a favorable production response.

The structure of milk production cost in urban areas differs from that in rural areas. Depreciation on all animals is higher in urban areas. In the IARS milk production studies, household labor was costed. The result is a higher percentage of labor cost for rural than for urban stables (23, 24, 26). Feed costs in urban areas make up 65 to 75 percent of cost, vs. 55 to 60 percent in rural areas. Expenditure for rent in urban areas contributes little to cost.

The capital investment required to produce milk for the fluid market vs. the product market does not differ in India, as modern equipment is not in use at the farm level, and no standards of sanitation are enforced at the production level by municipal authorities. Efforts toward quality control made by nearby villagers or urban producers for the purpose of improving their competitiveness require the employment of labor. In village production family labor is used; in urban stables some hired labor might be involved.

Investment requirements are not much greater for urban than for rural production. Urban operation is highly intensive dry-lot enterprise and the land requirement is small. Frequently, city stables are located on public lands and whatever rents are paid do not reflect the longer-run opportunity cost of the land in use.

The factors most important in contributing to greater costs of production in the rural subsidiary milk-production enterprise are feedgrain and fodder costs, and the opportunity for alternative employment of land and human resources.

The cost of milk production varies considerably among regions. This is a consequence of differences in climate, soils, and the traditional role of cattle in the village community.

Expansion of the milk supply area is a major achievement of urban fluid-milk market modernization. This expansion necessitates investment in mechanized transportation, and handling and storage facilities. Efficient use of this equipment is hampered by small, sparsely distributed dairy production units and by poor milk-handling practices in milk producing households.

Even under the best of husbandry conditions, neither the Indian cow nor the water buffalo is capable of the volume of milk production achieved by western breeds of dairy cattle. Under prevailing conditions the yields of these animals are strikingly low, amounting to less than 10 percent of U.S. yields. Yield statistics on Indian cattle are biased downward by the inclusion of all bovines in milk rather than just those bovines maintained as specialized dairy animals. The milk yield of both cows and buffaloes varies considerably among geographic regions and between urban and rural areas (table 2).

Considerable differences in milk yields between rural and urban areas reflects the separate functions which the animals serve in the different communities. These differences are more sharply pronounced when expressed in terms of production per milch animal, as relatively few dry animals are in

Table 2. **Average daily yield for animal in milk*, by regions and by type of bovine, India, 1953–1962**

Region	Year	Cow		Buffalo	
		Urban	Rural	Urban	Rural
		kilograms			
Punjab	1956–57	2.86	2.22	5.31	4.04
East Uttar Pradesh	1957-58	1.13	.68	2.22	1.86
Madras	1957–59	3.90	1.43	3.40	1.86
West Bengal	1960–62	.8–.9	1.0–1.5	—	—
Delhi	1953–55	4.2–6.0	2.2–3.1	7.1–8.8	5.1–5.5

Source: (25, p. 20); (23, p. 92); (24, p. 44); (27, p. 16); (26, p. 16).

* Yields are per animal lactating, not per dairy animal maintained; 1 U.S. quart = .975 kilogram.

urban regions (23, 24, 25, 27). Generally, a high proportion of the milch animals stabled in rural and suburban areas are dry (23, 24, 25, 27). In rural areas the low percentage of milch animals in milk is due primarily to the poor physical condition of the animals and the absence of commercial slaughtering of cows. The stage of gestation is also a contributing factor. As the buffalo is more frequently maintained specifically as a dairy animal, and is more subject to commercial slaughter when its productivity declines, the proportion of these animals in milk is high relative to the cow. A major factor contributing to the low overall percentage of buffaloes in milk (compared to temperate climate countries) is the tendency for these animals to calve only in alternate years.

Even in dairy herds of 25 or 30 head, daily milk yields of 3 to 5 kilograms per head would make milk assembly costly. The average number of livestock in most rural and suburban milk producing households is 2 or less (25, 26). With allowance for rural household consumption requirements, daily sales by individual households may commonly be only 1 kilogram or less. Marketings of 6 kilograms are probable only in the relatively superior rural agricultural areas. Quality of milk suffers both from difficulties in supervising the many suppliers and from time expended in the milk assembly process.

The buffalo produces greater quantities of milk with twice the butterfat content of cow's milk. Commercial dairy production in most rural localities is geared to ghee sales rather than fluid milk sales. Because buffaloes produce 6.5 to 7.5 percent milk fat they are preferred. Large numbers of buffaloes are maintained primarily to meet household consumption needs and the marketing of ghee is on an irregular basis. Domestic cows are maintained primarily for draft purposes. Because male calves are in competition with

the household for the milk production, this leaves even smaller quantities of cow's milk available for marketing.

Large seasonal differences in milk production levels create further difficulties in making effective use of dairy equipment designed for extensive expansion. The problem of seasonality of milk production is more severe in India than in countries of the temperate zone. This is due to the temperature and moisture effects of the monsoon upon breeding activity and production of fodder. Water buffaloes are difficult to breed, and the lactation curve is much more severe than for cows (figure 1). Comparative amplitude of lactation of buffaloes and cows has intraregional similarities (25, p. 24; p. 93).

Cows and buffaloes also differ in their calving periods. Buffaloes tend to calve during the rainy season (July–September), and Indian cows during the winter months (figure 2). This divergent pattern is very distinct in Northern India. In Southern India, the seasonality of calving of cows and buffaloes appears to be more comparable (24, p. 104).

Weather influences the breeding activity of the water buffaloes. In Northern India, the buffalo breeds with the arrival of lower temperatures, coupled with the availability of wallowing holes. Increased rates of conception in November and December result in calving in August and September. Temperature variations in the South are less pronounced than in Northern India. The more tropical a location, the more constant is the seasonal temperature pattern. In some areas, proximity to the coast is itself a moderating influence.

Seasonality in yields is less clearly defined for cows than for buffaloes. The amplitude of seasonality is more pronounced in Delhi than in Madras for both urban and rural regions. Pooled urban-rural data for the Punjab and Eastern U.P. indicate a similar amplitude of seasonality (23, 24, 25, 27).

Seasonality of buffalo production is greater in rural than in urban areas. This is consistent with the practice of removing dry or nearly dry animals from urban stables. Urban-rural seasonal patterns for cows are much less divergent.

Price indices for buffalo milk and buffalo ghee constructed from CSO retail price data reveal considerable inter-city differences in seasonal price movements and in the relationship between ghee and milk prices.[5] Generally, retail ghee prices fluctuate little. Ghee prices have not declined significantly since January, 1963, in areas where buffaloes dominate, such as Bombay, Delhi, and Ahmedabad. In seasons when retail milk prices are in decline,

[5] The absence of uniform grades or standards for milk in India has resulted in a deficiency in milk price statistics compared to price information on other major food items. The chief governmental statistical agency (The Central Statistical Organization) commenced publishing price information for *bazaar* milk in 1963. Information on the prices administered by the public sector dairy industry are generally available. Monthly urban retail prices for buffalo milk and buffalo ghee are presently published for eight cities throughout India. These prices are collected by local authorities under the guidance of the CSO. Throughout each month market quotations are recorded from selected establishments in each city and a monthly average price is computed.

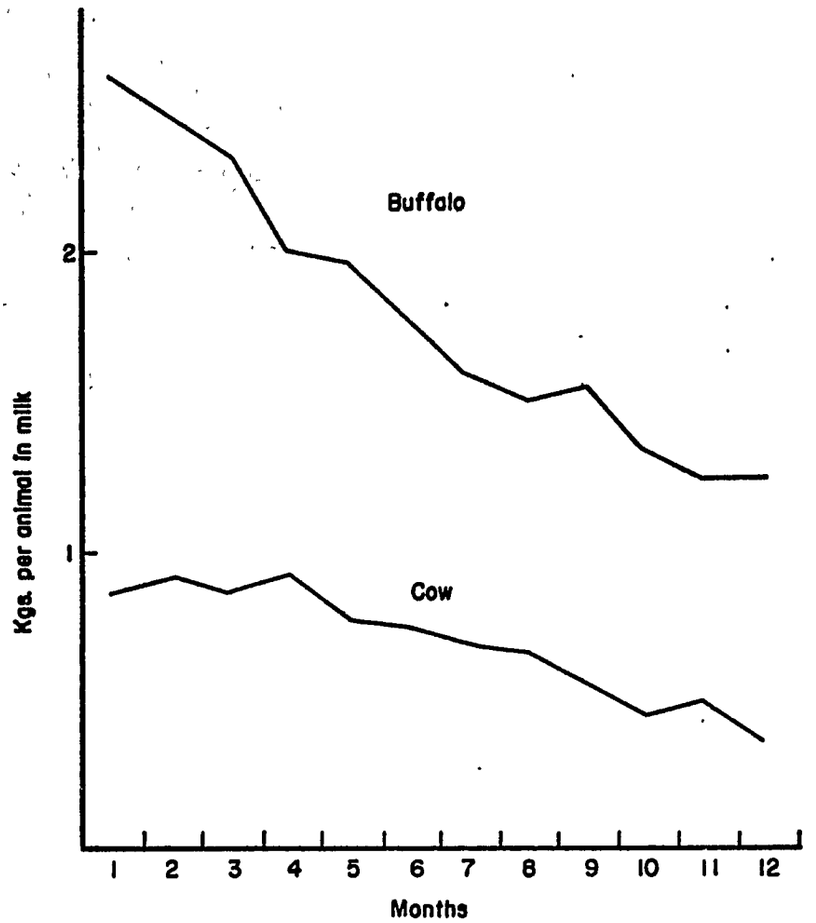

Figure 1. **Average daily yield by month of lactation for cows and buffaloes, Eastern U. P., India, 1957–58. (*Source*: Sample survey for estimation of milk production, ICAR report series 24, p. 47).**

ghee prices remain steady, rising again as milk prices turn up. The only evidence of seasonality, in retail ghee prices appears in Madras and Bangalore markets. The dominant source of fluid milk in these markets is the cow rather than the buffalo. Buffaloes are more frequently used as draft animals in these areas than in Northern India and calving cycles are probably more seasonal. Ghee requirements are purchased in part from other regions. There is no seasonal variation in retail ghee prices because it is in continuous production and stores well.

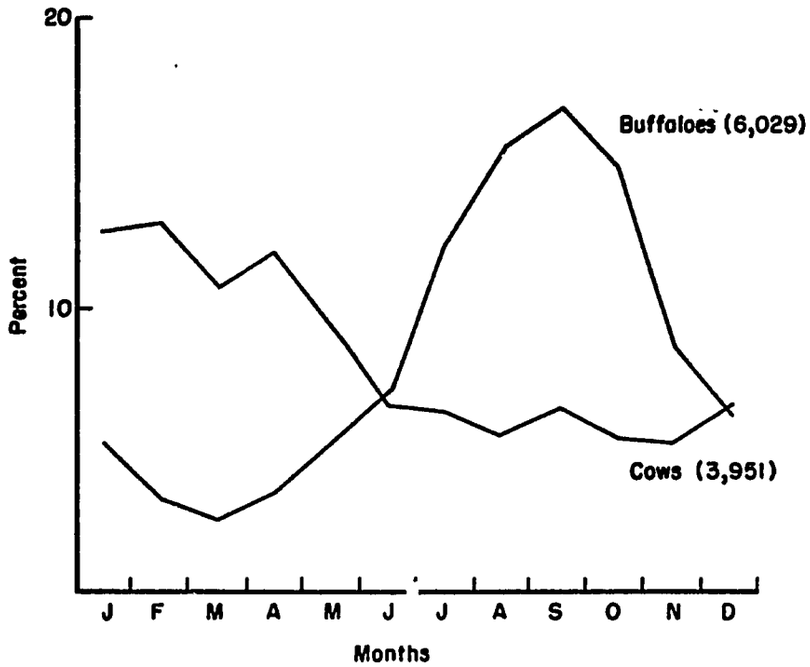

Figure 2. Percentage of cow and buffalo calvings by calendar month, Punjab, India, 1956–57 (*Source:* Sample survey for the estimation of milk production in Punjab, ICAR report, 1964, p. 82).

Seasonality in fluid buffalo milk prices was very pronounced in these larger cities where it is the preferred type of milk. Bombay prices fluctuated most widely with the seasonal low falling in December–January and the high during the hot summer months. The same pattern was evident in Delhi, but less severe. In Calcutta, Madras, and Bangalore, seasonality was slight.

Of the major cities, Bombay has achieved the greatest success in removing milch cattle from the urban center. Significant success has also been achieved in parts of Delhi. As urban and suburban milk producers engage in livestock marketing as a means of sustaining production levels, the removal of urban stables may have affected seasonality in prices.

Traditional milk marketing systems

A variety of dairy marketing entrepreneurs operate in every sizable urban center. These agents adapt their services to the particular demands of the communities they serve. Together they present a substantial competitive challenge to highly organized and standardized modern marketing systems.

The number of milk traders is excessive, and they perform their services in multiple ways. A principal variant among traditional milk marketers is the mode of travel employed in transporting milk.

Few cities have succeeded in enforcing zoning restrictions on urban stables, which are located near or within residential communities. In such cases, there is no specialized marketing agent and all milk marketing services are performed by the consumer or producer.

When the production enterprise is located in a suburban or rural area, transport becomes the major function of the milk marketer. Milk is not processed to retard spoilage, nor is it packaged. Milk is "dipped" into a vessel provided by the household consumer. Marketing agents do engage in altering the fat or total solids content of milk because cream is in demand for ghee manufacture. Shops engaged in preparation of traditional confections demand unaltered buffalo or cow's milk. Lower income households may accept milk with substantially reduced fat or total solids content.

Few statistical data are available on the size and number of particular types of traditional milk marketing agents. Only local health agencies have information on the activities of the trade. The function of these agencies is essentially that of policing. The data, even if available, would probably contribute little to the concept of market structure in the traditional system.

Any fluid-milk marketing system in India must incorporate techniques for limiting dilution. Milk has a very high unit value. A liter commonly costs as much as one-fifth of the day's wage of an urban clerical worker. Substantial increases in the earnings of milk marketing agents can be achieved by watering milk. Since 10 percent water is not detectable by taste, dilution in small quantities involves little risk (6, p. 18). A 10 percent watering of 20 liters of milk is equivalent to a day's wage of an unskilled laborer. The Indian consumer of liquid milk has a strong incentive to perform his own marketing services.

The owners of urban stables are as aware of the potential gains from watering as are their customers. Both the customer and the stable owner realize that the likelihood of dilution is reduced as the number of participants in the marketing process is reduced. Where urban stables are not situated in residential areas and intra-city deliveries are necessary, a member of the stable-owning household usually performs this task. Milk is carried by headload over short distances. Hand carts or bicycles are used in larger urban centers.

Extensive expansion of traditional milk markets is limited by the perishability of milk. When milk production is distant from residential areas, time becomes an important factor and transport by headload is too slow. Bicycle or rail passenger transport is used. Transport by motor vehicle is rare and marketing agents operating their own motor vehicles (two, three or four-wheeled) are almost non-existent.

In employing bicycle or rail transport, the traditional milk marketer avails himself of dependable transport at a low cost. The bicycle is the cheapest

method, except in areas having dependable rail service. Rail service may cost the milk-carrying passenger nothing; these passengers are not asked for tickets or use other than the usual exits from railway platforms. Some type of formal or informal reduced rate system appears to be in effect.

The limitation of milk transport by rail passengers lies in the scheduling of service. Where punctuality and regularity of services are demanded, the cycle offers peculiar advantages. It is readily available and the investment required is within the means of a large segment of the population. This single means of transport may be used from production point to the final consumer.

Efforts to improve on market performance through modernization of activities in the marketing channel may be inhibited by the structure of traditional markets in some areas.

Control over scheduling of activities is of critical importance to the traditional milk seller. If he serves as the sole intermediary between the producer (commonly himself) and the final purchaser, he benefits from opportunities for watering or fat reduction.

Various parties may alter whole milk prior to retailing. These range from members of the milk producing household to the *dudwala,* who purchases milk from urban shops and vends it in the street or to homes. Alteration frequently involves watering: part of this alteration is the removal of fat. The demand for fat as ghee results in the common practice of skimming the richer whole milk down to an "acceptable" level. Enterprises possessing hand-operated separators (commonly called "dairies" or "creameries") provide a market for butterfat for which the fluid milk consumer is unwilling to pay.

Significant progress has been made in the modernization of transportation in India. These systems are not readily adapted, however, to the needs of traditional marketing agents. Public bus service is not dependable. Vehicles which operate in rural areas frequently are privately operated and the payment of fares is enforced. Buses serve villages on fairly well traveled routes. Milk assembly in off-route villages would necessitate additional and rapid ancillary transport. Milk carriers are frequently observed aboard buses: but their number is small, as is the quantity of milk carried.

Use of large motor trucks or cars for milk transport necessitates basic changes in both rural procurement practices and urban distribution methods. They are limited to the assembly of milk for modern or pilot processing plants. Two- or 3-wheel motorized scooters or cycles may offer no advantage, except where multiple-marketing functionaries operate either on a co-operative or contractual basis. The high initial cost of motor vehicles prohibits their use regardless of which particular type seems advantageous.

It is difficult to judge how extensive the use of draft animals is in the transportation of milk. An animal that travels speedily, such as a bullock or a horse, requires considerable investment, but the carrying capacity is substantially increased over the cycle. This necessitates serving greater numbers of producers and consumers and entails secondary "capillar" procure-

ment and distribution systems to reduce time spent in transit. Reliance on numerous marketing agents again poses a dilution problem.

Market modernization programs

The modern dairy plants, particularly in the public sector, pursue a variety of objectives and do not concentrate their full efforts on the introduction of an economically efficient milk-marketing system. Emphasis on the provision of high quality but low priced milk for the urban masses results in the problem of conflicting goals. This is an objective of the Government of India, which is strongly enforced by international agencies granting assistance, especially UNICEF and the Food and Agriculture Organization of the United Nations.

Newly established plants anticipate an operating deficit for a period while they are under capacity, and a break-even financial operation after a few years. To meet the government's welfare objective and to aid in the introduction of new forms of service, the selling price of distributed milk is set substantially below that charged by the traditional milk trade. Dairies have generally attempted to procure milk in areas beyond traditional fluid milk supply regions to compensate for this. Milk purchase prices in these regions have been fixed at low levels, reflecting administrators' expectations of a prompt and substantial market response to a new marketing outlet.

Dairy plant management is responsible for operating the entire marketing system at a level of efficiency which will permit reasonably prompt elimination of public subsidy. Management must rely primarily on efficient operation of the procurement, processing, and distribution systems. The effort to reduce operating costs conflicts with another goal of the public sector, that of reducing unemployment. Sympathy with this objective causes management to institute employment policies which increase operating costs.

Imported dairy technology has innovated Indian milk markets. Efforts have been made to develop adaptive operational procedures in procurement, processing, and distribution. The problem of adapting dairy technology to fluid milk for Indian markets is particularly difficult. European and American processing equipment provides exceptional guarantees of quality. Containers are designed to insure maintenance of quality in marketing channels and to provide maximum convenience to consumers possessing refrigerators. This processing and packaging equipment is not easily adapted to a low income society because the services provided are costly. Local conditions of production and consumption require services not demanded in western dairy economies.

In advanced dairy economies, marketing systems are specialized. Some systems meet fluid demand, others provide dairy products. The Indian consumer is generally accustomed to purchasing whole raw milk, from which

numerous dishes are prepared. Absence of refrigeration has made this an essential household function.

In the modernized dairy-products sector, consumer preferences do not inhibit the use of available western processing technology. The success of the Kiara District Cooperative in Gujarat and several foreign, private dairy-product firms can be attributed largely to their program of product development and promotion. Development of the market for whole milk powder is significant. By 1967, three establishments had distributed modified whole-milk powder (baby food) to the public. The 1967 retail price of this product was 10 to 11 rupees per kilogram. The government of India is financing the construction of additional whole-milk powder plants in the cooperative sector. The output of these plants (2 of which were operating in 1967) went to specialized markets, but will eventually enter retail markets.

Other dairy products have been developed specifically to meet the requirements of Indian markets. Processed cheese is now manufactured from buffalo milk. Ghee is produced on a large scale and distributed in tinned containers; creamery butter and canned condensed milk are established products in India. The market for these products is primarily among higher income groups, with the possible exception of tinned ghee.

Government policy concerning food imports has a critical influence on the development of local industry. Inconsistency or lack of stability in milk powder import programs disrupts technological innovation and the evolution of consumption preferences.

Skimmed milk powder is second only to dairy equipment as a component of foreign assistance. Some powder has been donated and some purchased in world markets. National and international agencies (16) finance part of the skimmed milk powder purchases.

The major use of skimmed-milk-powder is in "toning" milk. Toned milk is whole milk that has been standardized through the addition of reconstituted skimmed milk powder. Distribution of standardized milk of 1.5 to 3 percent butterfat requires households to make adjustments in the manner in which they use the product. Toning of milk increases the demand for ghee and vanaspati, since urban household ghee making is not possible using the lower fat product.

During the 1960's, the supply of skimmed milk powder fluctuated substantially (16). Plants are designed, based on a continuous powder availability; supply instability results in low production. Differences in availability of powder force plants to make frequent adjustments in product lines and procurement policies. These adjustments increase the difficulty of achieving consumer acceptance of new products.

Problems caused by variations in available powder extend to traditional markets. Lower retail prices made possible by the use of skimmed powder, reduce incentives for marketings through traditional systems. Retardation of urban and suburban production adds to milk shortages when powder imports are reduced.

Chapter 3.

Traditional Milk Marketing Systems in Delhi — A Case Study

Selection of locality and implementation of survey

Numerous studies have been made of households producing milk for sale in traditional milk markets. No studies have been directed toward the description and quantitative analysis of the activities of the traditional marketing agents. Preliminary investigations indicated that a high proportion of milk marketers are livestock-owning residents of nearby villages. It appeared that the most fruitful approach to obtaining data on the traditional market would be to conduct a survey of village households in an area known to be active in the production of milk for sale in urban centers.

The site selected for the survey was the Mehrauli block area of South Delhi. The IARS 1953–55 study of milk production in Delhi territory indicates that villagers in the block were active in milk selling (23). Initial inquiry through the offices of the staff of the Indian Cooperative Union and the Mehrauli Block Development office indicated that the projected survey could be implemented and would yield meaningful results. The IARS study showed that (on the basis of stable size) the Mehrauli area was at that time the most highly commercialized rural milk-producing area in the territory (23, p. 56). Collected data confirmed observations that little or no milk moved from the Mehrauli area by railroad and that the Delhi Milk Scheme was not procuring milk there. The cycle-dudhia system was the only significant traditional system in operation. A separate study of households possessing livestock located near railroad passenger stations would be useful in assessing the impact of the rail system on production and marketing activity.

A major source of problems in milk markets is the seasonal nature of production and marketings. This survey was therefore implemented during each of three seasons. The IARS also presented its estimates of Delhi milk production on a seasonal basis. The year is divided into summer, rainy, and winter seasons, with the divisions falling on March 1, July 15, and October 15 (table 3).

The seasons identified by IARS are those applicable in the Delhi area for buffalo milk production, which is the major milk source. Buffalo calvings are highest during July through October. Increased feed supply from September through December (provided monsoon rains are normal) results in

Table 3. **Delhi milk production seasons and village survey dates**

	IARS milk production seasons, Delhi	Mehrauli survey periods	Mehrauli marketing seasons
Summer	Mar. 1–July 15	June 1–July 5	April–July
Rainy season	July 15–Oct. 14	Oct. 5–Nov. 20	Aug.–Nov.
Winter	Oct. 15–Feb. 28	Jan. 15–Feb. 10	Dec.–March

Source: (25, p. 24).

improved physical condition of the animals. Coupled with greater availability of wallows and lower temperatures, the rate of conception rises. March through mid-July, therefore, is the period when the largest number of buffalo are in the later stages of lactation. The level of milk production increases from mid-July through mid-October to a high level, but declines from mid-October through February to low levels. It also decreases from March through mid-July.

The seasonality of calvings for cows is not as clearly defined as for buffaloes. Peak calvings are early in the calendar year. Production is highest February through March and lowest in the monsoon season.

To assess seasonal variations in Mehrauli milk marketing activity and budget dudhia operations, a different season from those used by the IARS (table 3) is appropriate. Here the season lagged a month. The IARS seasons are based on observed animal reproductive processes, whereas the marketing seasons are defined on the basis of significant differences in marketing activity. Although the rainy season did commence in July of 1966, the initial effect of the weather retarded marketing activity because of a deterioration in road conditions. In some villages it was difficult to transport milk. Although the calving rate rose, few animals were at the peak of their lactation. The level of milk prices probably had not commenced to decline from the dry season level, although in the less accessible villages, it may have declined due to road conditions. The effect of rains on levels of milk production through improved availability of feeds also lags behind the seasons as defined either on the basis of rainfall or calvings. Each of the marketing seasons, as represented by the actual survey period, is four months (table 3). The marketing seasons defined are fairly well represented by the Mehrauli data, the greatest deviation being in the rainy season. Marketing seasonality lags production seasonality: survey periods also lag. Therefore, the 1966–67 Mehrauli data for buffalo milk production in summer and winter tend to have a downward bias and rainy season data have an upward bias relative to IARS data. Cow milk production may have an upward bias in winter and rainy seasons and a downward bias in the summer.

The date and duration of the monsoon rains are the most important fac-

tors affecting seasonality. The production impact of yearly rainfall variations is evident in comparative IARS data for 1953–54 and 1954–55 (23, 24, 25, 27).

The rainfall situation in the Delhi area during 1966–67 was mixed. Southwest monsoon rains were normal. The winter rains which normally take place in January and February were extremely poor. Thus, the availability of green fodder was abnormally low for the 1967 winter survey period. Rainfall in the Delhi area was also below normal in 1965–66, as it was throughout India. Data from the household survey reflect a relatively low level of milk production.

Rainfall data for the Punjab and Delhi zones evidence the abnormal rainfall situation, as well as the relationship of rainfall to the milk production seasons which have been defined (table 4).

In May 1966, officials of the Delhi state government agreed to make available results of the household livestock census conducted in April, 1966. The household lists compiled by the census takers provided the sampling base for the selection of village households. Twelve of the 36 villages which now constitute Mehrauli block were selected by employing stratified random sampling. The block is divided into three primary north-south strata on the basis of geographic proximity to New Delhi markets, with allowance for road distances. The two strata closest to New Delhi were then divided into an east-west stratification reflecting variability in the quality of agricultural land and water resources (figure 3). Villages located in the southern and eastern areas of the block are at a higher elevation and have greater rock

Table 4. **Rainfall in the Punjab, Haryana, Delhi rainfall zone, 1965–67**

		1965–66	1966–67
		millimeters	
Rainfall seasons:			
Pre-monsoon	March–May	79	46
S.W. monsoon	June–Sept.	309	587
Post-monsoon	Oct.–Dec.	29	11
Winter monsoon	Jan.–Feb.	19	13
IARS milk production seasons:			
Summer	March–June	82	145
Rainy season	July–Oct.	319	499
Winter	Nov.–Feb.	35	13
Annual		436	657

Source: Compiled from rainfall statistics reported by the Director General of Observatories, Poona. Agricultural Situation in India, volumes 20–22, Directorate of Economics and Statistics.

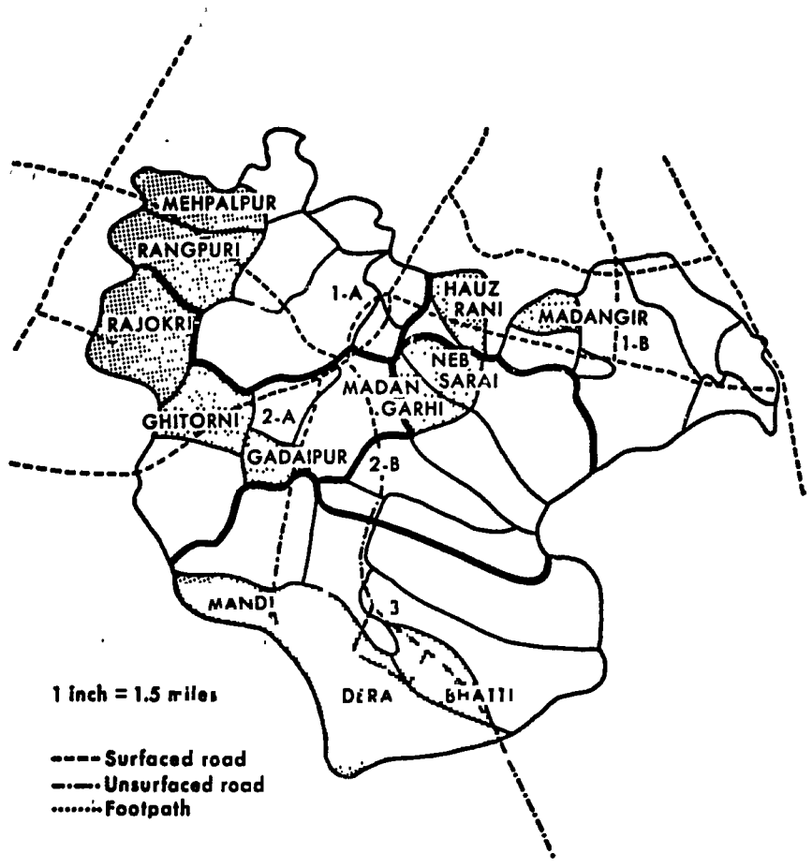

Figure 3. **Map of Mehrauli Block, South Delhi, India.**

outcroppings and stony soils.[6]

Each of the five strata or "zones" was weighted by the milch cattle population recorded in the 1961 livestock census, in selecting sample villages. The proportion of a sample of 12 villages drawn at random from each zone was based on the proportion of the total block population of milch animals. Estimates of statistics for the block are zone averages weighted by the number of villages in the zone.

A random sample was taken of the households owning livestock in each of the 12 villages using the April, 1966, livestock census lists. Non-selling households were excluded by interview in villages having many milk sellers. In villages with few livestock owners engaged in milk selling, village leaders

[6] National Atlas of India, Delhi, Plate 110.

were asked to identify the sellers from the random household list. This identification was repeated in each season. If, during the interviews of households, it appeared that information provided by village leaders was not accurate, the random list of households was submitted to other village members for review.

During June and July a total of 129 households in the 12 survey villages were identified as habitually engaged in milk selling. Of these "milk-selling" households, 30 actually reported no sales on the date they were interviewed during the summer season or on the date of interview during either of the subsequent seasons. Thirteen of the milk-selling households were identified as dudhias engaged in milk collection and distribution by bicycle.

To properly reflect the characteristics of the livestock enterprise in milk-selling households, it was necessary to make a judgment as to the status of the 30 households identified as "sellers" but reporting no sales. A particular household which should be classified as commercial might not be selling milk on any of the 3 days during the year on which it was interviewed. Failures or delays are common in efforts to bring about lactation in water buffalo and the duration of lactation is unpredictable. Also, milk is periodically withheld from the market for use in preparation of special holiday or ceremonial dishes.

From the random lists of livestock households it was possible to classify livestock owners into 3 tentative activity categories.

Classification	Percent of households
Commercial — active	30.0
Commercial — inactive	8.9
Non-commercial	61.1

April, 1966, livestock census data were available for most of the commercial households as were census totals for each village. It was thus possible to estimate livestock numbers per household in April, 1966, for each of the selling activity classifications.

Average livestock numbers for April were computed for those census households in the June–July sample. The resulting estimated inventories of different types of bovines in commercial-active and commercial-inactive households were applied to the corresponding proportion of total census households as estimated from the random household lists. Total livestock numbers for non-commercial households are derived as a residual from which household inventories are estimated. Comparison of household livestock inventories in the different commercial classifications indicates that commercial-inactive households are more similar to commercial-active than to non-commercial, particularly with respect to buffalo. Commercial-inactive households are representative of less active sellers and therefore are in-

cluded in the analysis of activity in the traditional milk marketing system of Mehrauli.

General description of Mehrauli

Mehrauli block consists of a group of 36 villages situated directly south of New Delhi and southeast of Palam Airport and the military cantonment area. Agricultural resources of the Mehrauli block area are generally inferior to other regions of Delhi territory. The area is higher in elevation and there is a considerable quantity of rock outcropping and clay deposits. Irrigation is either by wells or by tanks, whereas some other regions of Delhi are served by canal systems. Except for the extreme southern part of Mehrauli block, wells are very plentiful and are used extensively. Many of the wells are electrified. Although the block is not deficient in agricultural resources, it is at a disadvantage compared with other areas in Delhi in reference to the production of a crop such as sugar. It is possible that the subsidiary milk production enterprise is favored due to the comparative disadvantage in the production of purely cash crops.

Census data indicate that the proximity to Delhi has caused a decline in the population of a few of the sample villages. This decline does not appear to be correlated with observed differences in agricultural resources. The village having the greatest number of vacant residences is Ghitorni, the most active milk-selling village.

The road system within the block is adequate for relatively slow moving traffic and is well maintained. The majority of the villages are served by asphalt surfaced roads which are sufficiently wide to permit vehicles to pass. Some, however, are completely isolated from motor vehicle traffic.

The relative importance of non-agricultural economic activity in the block is reflected in employment statistics for 1961 (table 5). Clay deposits provide the foundation for brick and pottery manufacturing. Large quantities of crushed stone and loose rock are used in Delhi construction work.

Role of the cycle-dudhia in traditional marketing — Delhi

A high degree of interaction takes place between the fluid and other milk-products markets in Delhi. This integrated market system has developed in response to urban patterns of milk use. The creamery or manual separator operator plays an important role in this system (figure 4). The dairy provides an outlet for cream, which is not demanded by the urban fluid-milk consumer. Those customers who purchase only for fluid consumption are willing to relinquish a part of the fat content in return for price reductions. For the lower and even middle income groups this is a necessity, as whole milk is priced beyond their means. The increasing quantity of vegetable fat on the market has decreased the need for low income household purchases of

Table 5. **Employment Classification in Mehrauli, 1961***

	Employment	Percent
Cultivation	2,568	50.0
Agricultural labor	81	1.5
Mining, quarrying	287	5.7
Household industry	141	2.7
Manufacturing (pottery and brick kiln)	389	7.6
Construction	217	4.3
Trade and commerce	164	3.3
Transport and storage	69	1.3
Other	1,213	23.5
Total	5,129	100.0

Source: 1961 Census data, Bureau of Economics and Statistics, Delhi Administration.

* Rangpuri village is excluded.

high butterfat milk for ghee making. A ready market exists for butterfat in the form of ghee and the milk sweets industry provides a market for cream. The consumer thus can purchase the more important (from a dietary viewpoint) protein and calcium components in liquid form. The system also operates as a seasonal balancing device. In seasons of short supply the price adjustments are blunted by reductions in fat content, a system far preferable to watering.

The dairy (separator operator) is shown in the diagram of market channels to have a monopoly on butterfat removal. Of course, many milk processing operations are carried on in the producing households in both the urban stables and nearby villages.

Although the urban stables are important urban milk suppliers, they engage in little marketing activity. Transactions are primarily between the consumers and the stable, the consumer performing for himself the few essential marketing functions. The higher input costs in urban production are reflected in selling prices.

In the Mehrauli area, milk hauling aboard buses was rarely observed. Many villages which were served by cycle-dudhias could not be reached by a bus and others were not on regular bus routes.

Use of public or private road transport entails establishing an intermediate link between bus stops and unserviced villages. If a cycle is employed because distances are too great for transport by head-load, there is little to be gained in public transport save a reduction in labor input at a considerable cost in convenience. Time in transit is not greatly reduced over distances of 3 or 4 miles.

Milk transportation has undergone some modernization over the years with the bicycle replacing animal power. The bicycle requires a large quantity of labor input but the investment required is less than that for a bullock

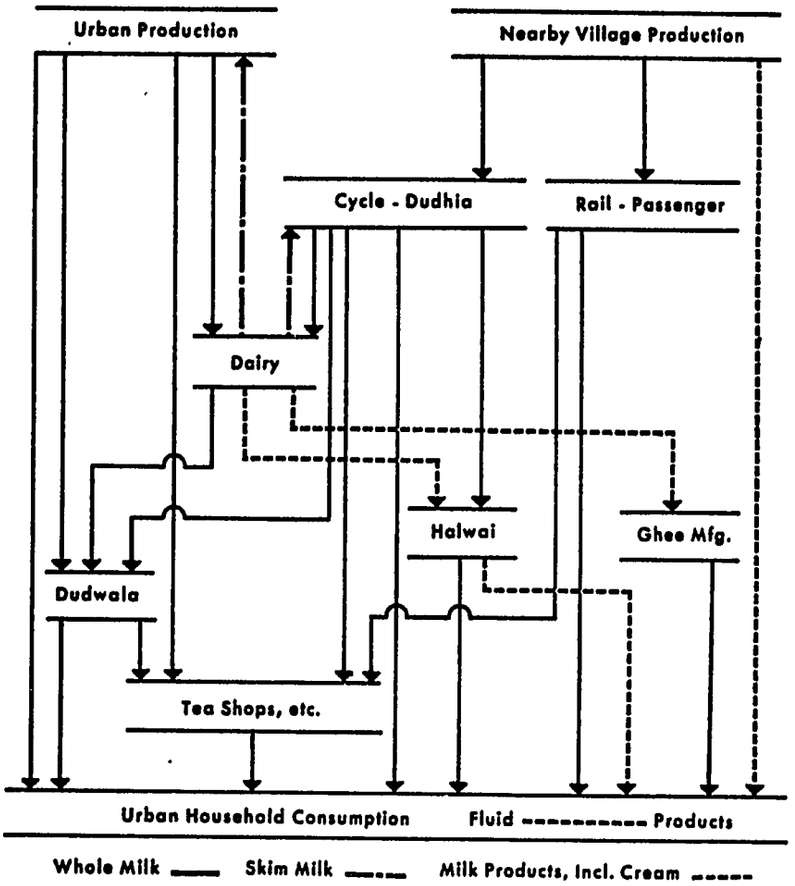

Figure 4. **Diagram of traditional milk-marketing channels in Delhi, 1966–67.**

or a horse, animals which also would have sufficient speed for profitable use. By expansion of the "perishability boundary" to more distant villages, the faster moving cycle increases employment both within the villages and in the transportation process. Animal transportation is too slow to move milk over great distances and the cost of maintaining a draft animal is increasing faster than unskilled wages. Also, most labor employed is family labor and is thus subject to discount by the entrepreneurial household.

The cycle-dudhia operation is highly flexible in the type of services it renders and in the recipients of these services (figure 4). In the Mehrauli block area the dudhia is generally a member of a milk producing village

household. He services his own production enterprise in addition to several other milk producing households. These additional households are generally in the same village in which the dudhia lives, although occasionally a village is served by an outsider. Because of the trust required in such cases, the outsider is probably related to village members. Generally, it is not possible for a single dudhia to serve multiple villages, as this lengthens the required procurement time and likelihood of spoilage. The dudhia could not milk the animals in more than one village and this would increase the possibility of receiving boiled milk or watered milk.

The importance of the dudhia system in the villages surveyed is reflected in the householders' selling outlet (table 6). The distant villages in zone 3 are completely dependent upon the dudhia for a commercial market. Intra-village sales are somewhat more common in zone 2. In the villages bordering the urban center, direct sales to urban consumers, intra-village sales, and dudhia sales are of about equal importance.

Households selling directly to dairies or to *halwais* are of minimal importance, although both types of establishments are prevalent in Delhi and at various localities within Mehrauli block. A halwai is a milk shop situated in the *bazaar* area of larger villages or towns. This establishment makes milk based sweets and sells hot milk. Such a shop also may make deliveries of milk to surrounding households. Both the dairy and the halwai are supplied by dudhias.

Village households do not report sales to the dudwala. In urban centers this expression may refer to a cycle-dudhia, an urban stable operator, or an employee of a stable or a halwai. It may also refer to an independent peddler who participates irregularly in milk buying and selling.

The marketing channels depicted in figure 4 indicate the major activities involved in fluid-milk marketing and the interaction of these activities with the milk products sector. Marketing institutions which move milk products, such as ghee, from village households to urban consumers are not shown.

The cycle-dudhias based in the villages of Mehrauli sell throughout the

Table 6. **Fluid milk sales outlet of Mehrauli village household, 1966-67**

Purchaser	Zone 1	Zone 2	Zone 3
	Percentage of selling households		
Village consumers	28.6	14.1	—
Urban consumers	33.9	—	—
Cycle-Dudhia	35.7	83.5	100.0
Halwais	1.8	1.2	—
Dairy (creamery)	—	1.2	—

Source: Mehrauli survey.

New Delhi area and the military cantonment area, delivering milk as far north as Connaught Place, 6 to 8 miles from the villages. House to house deliveries and institutional sales are made in this area. The major selling activity is in the residential area of New Delhi, north and south of Ring Road.

Entry into the cycle-dudhia trade is limited to persons residing in the villages because of the degree of trust demanded. Within the villages, the number of dudhias seems to be governed by the number of households choosing to market milk.

The working day of cycle-dudhia begins early. Working hours are determined by distance from customers and the extent of rapport with household suppliers. The dudhias milk the animals of the village suppliers from time to time. The village procurement process takes at least 1 or 2 hours. The dudhias assemble the milk, pour it into galvanized milk cans, and attach these to specially constructed brackets astride the rear wheel of the cycle and on the handlebars. Small cream containers are attached to the crossbar. In hot weather, the cans are wrapped in soaked burlap. The handlebars of the cycle may also be wrapped in heavy burlap to cushion and steady the front load. Cyclists peddle (and occasionally push) to the locality of their customers and make a varying number of individual deliveries. The morning trip commences between 3:00 and 6:00 a.m. and the dudhias return between 8:00 and 10:00 a.m. The men sleep during the hot period of the day and the complete operation is repeated during the corresponding afternoon and evening hours. The dudhia frequently is the healthiest and most rubust-looking man in the village. The physical exertion of his profession demands this.

Both cash receipts from urban consumers and payments to supplying households are on a monthly basis. Monthly payment of government employees among the customers provides incentive for this type of credit arrangement. It is facilitated by the use of standard size measuring dippers. Dudhias do complain, however, of problems in collecting accounts.

Milk pricing in Mehrauli market

During the period of the Mehrauli survey both milk and ghee prices were in a sharp inflationary trend in most Indian urban markets. The cost of fodder and concentrate feeds was rising sharply in Mehrauli. The survey commenced in the month of May, following deficient winter and southwest monsoons.

Seasonal differences in the household selling price for buffalo milk were small for the Mehrauli block as a whole. Variation was greater in the zones closest to market. This suggests that the dudhia is absorbing price changes for households situated in distant areas. The small number of milch buffaloes per household and the low proportion of these animals in milk require the dudhia to seek new suppliers frequently to maintain a stable sales

volume. In areas where the price levels are comparatively low, frequent and major price changes could lead to instability of supply. In the villages closer to dudhia serviced markets the price is more closely tied to conditions of supply and demand, and the margin over ghee prices is greater.

During 1966–67, the ghee price in Mehrauli was 10 to 11 rupees per kilogram. Assuming a ghee price of 10 rupees with 7 percent fat, the value of fat is 0.70 Rs. per kilo of whole buffalo milk equivalent. Summer whole milk selling price per kilo in Mehrauli block was Rs. 0.98 and the rainy and winter seasons' price was Rs. 0.85 (table 7). Households selling whole buffalo milk in summer received Rs. 0.28 for nonfat solids per kilogram of whole milk equivalent. In the rainy and winter seasons the additional return for whole milk sale was Rs. 0.15 per kilogram. Unless the skim or buttermilk retained by the ghee selling household is valued very low, the households consider leaving the fluid milk market during the flush season. This is particularly true of households located in zone 3, where the milk price drops to Rs. 0.78 in the rainy season.

Locational aspects of production and marketings

The households survey conducted in Mehrauli block during 1966–67 falls in the region classified as "suburban" in the IARS study. The residents were primarily engaged in cultivation and livestock raising. Many people were employed within the block by stone quarries, small-scale brick manufacturers and pottery makers. Numerous small urban-owned commercial farms in the region engaged in the production of vegetables, fruits, and poultry. Some of these enterprises were operated by "gentlemen" farmers, retired armed forces or government employees. None of these were engaged in commercial milk production. A large proportion of the village households in the region

Table 7. **Household milk prices by zones and by seasons, Mehrauli, 1966–67**

Bovine	Season*	Zone 1	Zone 2	Zone 3	Block
		rupees per kilogram			
Buffalo	S	1.129	.950	.830	.980
	R	.875	.873	.776	.849
	W	.927	.823	.789	.849
Cow	S	.893	—	.810	—
	R	—	—	—	—
	W	1.05	—	.680	—

Source: Mehrauli survey.

* S = summer; R = rainy season; W = winter; as defined in table 3.

kept milch animals. Subsidiary production and marketing activities of these households illustrate the importance of proximity to market in traditional agriculture.

Geographical stratification of the random sample of Mehrauli villages provides a basis for analysis of proximity to market. The 3 villages of zone 3 are 8 to 10 miles from their urban market and the 5 villages of zone 2 are 4 to 8 miles distant. Two of the 4 villages in zone 1 are adjacent to the consuming urban population and 2 are from 1 to 4 miles distant. Of the sample of 135 commercial households, 34 are from zone 1, 64 from zone 2, and 37 from zone 3. The sample sizes reflect the weighting of the sample by milch animal numbers.

The interzonal differences in household production and use of milk indicate the significance of proximity to market (table 8). Milk production is substantially higher in the closer zones. The quantity of milk used in products is generally lower in nearby zones, whereas fluid-milk sales increase sharply. These sales are particularly high in the summer in zone 1, presumably in response to the high price level (table 7).

Village household milk selling prices. Household selling prices for milk were quoted for buffalo's milk, cow's milk, and mixed milk. Quotations for cow's milk are generally too few to permit computation of an average price (table 7). The prices quoted for sales of mixed milk (cow's and buffalo's, and occasionally goat's) are similar to buffalo milk prices. The winter price in zone 1 indicates cow's milk may bring a premium over buffalo's milk in the Delhi market, as the city contains many immigrants from regions such as West Bengal, where the preference for cow's milk is particularly strong.

The selling price of milk declines substantially in the more distant zones (table 7). The summer price differential between zone 1 and zone 3 was Rs. 0.30 per kilo, vs. Rs. 0.10 in the rainy season and Rs. 0.14 in winter. The higher summer price differential may be due to increased likelihood of spoilage for milk transported over greater distances.

Interzonal comparison of household milk use indicates the lower prices in zone 3 are not sufficient to outweigh income declines in influencing consumption (table 8). Milk consumption per household in zone 3 is generally 1 kilo less per day than in zone 1. Per capita consumption is correspondingly less, as household size is 9 in each zone.

The varying degree of commercialization among zones, as expressed by household sales volumes, has a major influence on the composition of livestock inventories (table 9). On an *annual* basis, milch buffaloes exceed milch cows by more than 3 to 1 in zones 1 and 2, whereas in zone 3, milch cows outnumber milch buffaloes. The proportion of both buffaloes and cows in milk declines consistently as the distance from the market increases. While the average household inventory of milch buffalo is similar for all zones, milch cow inventories in zone 3 are 5 times those in zone 1 and 2. Cow numbers in zone 1 and 2 may reflect the influence of commercialization on local attitudes toward the slaughter of livestock. Although, on an annual

Table 8. **Household use of milk production by zones and by seasons, Mehrauli, 1966–67***

Use category	Season	Zone 1	Zone 2	Zone 3	Block
		kilograms per household			
Fluid sales	S	14.25	6.66	3.63	8.45
	R	8.43	6.13	3.53	6.25
	W	7.00	6.10	3.87	5.84
Milk to products	S	.19	.91	.48	.56
	R	2.04	1.90	1.19	1.77
	W	2.80	2.66	1.52	2.42
Liquid consumption	S	2.98	2.35	1.93	2.46
	R	2.86	2.26	1.53	2.28
	W	2.63	2.35	1.70	2.28
Production	S	18.91	9.53	5.47	11.64
	R	12.80	9.94	5.55	9.80
	W	12.51	11.34	6.99	10.64

Source: Mehrauli survey.

* The average number of household members is 9 in each zone.

basis, the proportion of cows in milk increases with proximity to market, the shift is insignificant compared to buffaloes. Ninety-three percent of buffaloes in milk in zone 1 indicates a high rate of transfer of animals in and out of the more commercialized stables.

Seasonal comparisons of livestock inventories provide a better basis for describing livestock transfers among zones and the relation of these to price changes and shifts in milk utilization. The locational distribution of milch buffaloes per household differs basically among seasons (table 9). In zone 1, numbers of milch buffaloes decline from summer through winter, the reverse of zone 3. For the block as a whole, milch buffalo inventories are higher in the summer, while the proportion of animals in milk is lower. This indicates a movement of milch buffalo into the block as fluid milk prices rise (table 7). As the proportion of buffaloes in milk increases in the rainy and winter seasons, buffaloes are again moved. Similar movements of milch buffalo are observable among the zones. The proportion of buffalo in milk in zone 1 is stable at a high level. In zone 2, these proportions are more similar to those for rural Delhi, as indicated in the 1953–55 IARS studies. In zone 3, the proportion of buffaloes in milk is similar for summer and winter, but at a much lower level than zone 1.

It is apparent that in Mehrauli block the marketing of milk and bovines is an integrated operation. The market values of milch cows and buffaloes at various stages of lactation and movement indicate that animals in the later

Table 9. **Average household inventory of milch animals by seasons and by zone, Mehrauli, 1966–67**

Bovine	Season	Zone 1	Zone 2	Zone 3	Block
		percent			
Animals in households:					
Cows	S	.46	.57	2.02	.90
	R	.60	.38	2.81	1.06
	W	.55	.32	3.48	1.19
	1966–67	.54	.42	2.77	1.05
Buffaloes	S	2.13	1.81	1.37	1.80
	R	1.80	1.46	1.81	1.66
	W	1.44	1.53	2.13	1.65
	1966–67	1.77	1.60	1.78	1.70
Animals in milk:					
Cows	S	.57	.30	.31	.39
	R	.33	.33	.17	.29
	W	.42	.48	.21	.39
	1966–67	.44	.37	.23	.36
Buffaloes	S	.92	.57	.48	.66
	R	.91	.77	.57	.77
	W	.96	.81	.43	.77
	1966–67	.93	.72	.49	.69

Source: Mehrauli survey.

stage of lactation are transferred out of the fluid-milk market. This permits an assessment of the extent to which ghee selling and household consumption in the more distant areas is supported by animals in the later stages of lactation. Data on transfer prices of bovines were not recorded in the Mehrauli Survey. IARS data on purchase and sale prices of milch bovines in suburban Delhi also provide only limited observations. However, 1953–55 sale prices of milch buffaloes in urban Delhi (23, p. 97) indicate a decline of about 25 percent in the first half of the lactation and only slightly thereafter. The 1966–67 Mehrauli prices range from 800 to 1000 rupees per milch buffalo. The cost of exchanging a fresh animal for one in later stages of lactation would be approximately 250 rupees.

The length of time that animals remain out of the fluid market depends on where and when the animals are bred. Villagers in the milk selling households of Mehrauli indicated that cattle were bred as soon as they were observed to be in heat. Breeding bulls are provided in each village by the Block Development Office. The duration of the buffalo's maintenance outside the fluid-milk market depends upon success in breeding the animals.

Table 10. **Household milch animal inventories for zone 3 villages, Mehrauli, 1966–67**

Bovine	Season	Village		
		Bhatti	Mandi	Dera
Milch buffaloes in households	S	1.50	.93	1.81
	R	2.27	1.64	1.58
	W	2.73	1.71	2.08
Buffaloes in milk	S	.47	.54	.45
	R	.36	.65	.73
	W	.17	.50	.68

Source: Mehrauli survey.

During much of each lactation period buffaloes serve the ghee market or individual village household consumption needs.

Although the reason for moving dry animals and animals near the end of the lactation period out of zone 1 is readily apparent, acquisitions in zone 3 are not. Milch buffalo inventories on an individual village basis in zone 3 (table 10) indicate larger summer-through-winter inventories confined to Bhatti and Mandi. One reason for this is the difference in accessibility of these villages. Dera is served by a dirt and stone road which can be travelled by cycle except during the heaviest monsoon rains (July and August). Bhatti and Mandi are accessible only by cycle-foot paths which cannot be negotiated by a loaded cycle (Figure 3). The cyclist must dismount and push the cycle. While the "road" to Mandi was used by the dudhias in all seasons, the "approach" to Bhatti actually shifted as cultivators plowed under the road. The distance which cycles had to be pushed was considerable.

Accessibility appears sufficiently different to set Dera apart from Bhatti and Mandi. The differences in accessibility between Mandi and Dera were not as great as between Bhatti and Dera, but were sufficient to be critical at certain times of the year. Milk product use varied considerably among the three villages (table 11). Utilization in Mandi and Dera was quite similar although at different levels. Fluid-milk sales in Bhatti declined to zero in winter. No ghee sales were indicated for Mandi and Dera. Sales were indicated in Bhatti during the rainy and winter seasons, when milch buffalo inventories are greatest.

The survey team observed land resources in Bhatti were relatively poor. It is unlikely that a favorable fluid-milk price would shift milk production and utilization in Bhatti to that of more accessible villages. The proportion of tillable land appears to be less than for other villages in zone 3; the elevation is higher and wells are deeper. As a result, fodder is in short and irregular supply, except for the rainy season.

Table 11. **Household use of milk in the villages of zone 3, Mehrauli, 1966–67**

Use category	Season	Village		
		Bhatti	Mandi	Dera
		kilograms		
Production (daily)	S	6.48	3.54	7.28
	R	3.70	4.93	8.36
	W	4.32	5.68	10.93
Fluid sales (daily)	S	4.12	2.60	4.51
	R	1.19	2.89	5.84
	W	0	3.93	7.36
Milk to products (daily)	S	1.31	.27	0
	R	1.05	.38	.89
	W	2.76	.74	1.52
Ghee sales (monthly)	S	0	0	0
	R	.67	0	0
	W	1.35	0	0

Source: Mehrauli survey.

It is significant that the village which reported the highest per household sales of ghee is Neb Sarai. This village, although located in zone 2, close to both Mehrauli town and Delhi markets, is accessible only by cycle and foot path. The road can be negotiated with a scooter by one familiar with specific obstacles, but it is a difficult and hazardous route for a loaded cycle. Road construction at the time of the last round of the survey, made the approach to the village temporarily even more difficult. The larger volume of ghee sales occurred in winter. Villagers in the sample reported all fluid-milk sales were to local village consumers.

Local fluid-milk sales were also significant in Mehpalpur, Madangir, and Hauz Rani in zone 1, and Gadaipur in zone 2. This is traceable in part to increased rupee incomes (table 12). In those instances where internal village sales were small and coupled with non-agricultural incomes, many households owned livestock.

Variation in the serviceability of marginal roads appears to be the critical factor in determining the marketing activity of particular villages. None of the most distant villages surveyed was on a through road. Bhatti, Mandi, and Dera are terminal villages. Dudhias in zone 2 served markets at a distance of 8 miles, indicating dudhias serving markets in the residential areas of southern New Delhi could procure milk from even more distant villages, given improved roads. Cycle-dudhias do bring milk down the Grand Trunk road from northern Delhi territory and operate as far north as Alipur.

The relative price levels of ghee and fluid-milk limit how much a dudhia

can demand for additional effort expended in servicing a poorly situated village. The price situation in Bhatti illustrates this (table 13).

With a rainy season price of Rs. 0.76 for fluid milk and Rs. 11 for ghee per kg., the value of 10 kg. of fluid milk is Rs. 7.60, while the ghee yield from 10 kgs. of 6.5 percent buffalo milk sells for Rs. 7.15 If ghee is sold, the household keeps the milk curd for home consumption. Termination of fluid milk dilution does not necessarily eliminate gains from product alteration, as buffalo ghee also can be adulterated. A convenient means is with boiled potato.

Changes in the level of milk production per animal in the Delhi market and the corresponding price fluctuations determine marketing activity in a particular season. Price levels for fluid milk in zone 3 villages (table 13) were lowest in the rainy season. Seasonal changes were minor, however, except for the summer price in Mandi.

Seasonality in milk production and marketings

The effect of seasonal milk production on locational aspects of production and marketing activity within Mehrauli block has been discussed. When the block is viewed as a single unit supplying milk to the Delhi urban market, other important aspects of seasonality are evident. Seasonality of milk

Table 12. **Internal milk sales and external rupee income by villages, Mehrauli, 1966–67**

Village	Proportion of livestock-owning households with non-agricultural rupee income	Proportion of milk sales within village
	percent	
Mehpalpur	.20	.33*
Rangpuri	0	0
Hauz Rani	.10	.79*
Madangir	.44	1.00
Gadaipur	.60	.60
Ghitorni	.36	0 †
Rajokri	0	0
Madan Garhi	.46	.08†
Neb Sarai	.36	1.00
Bhatti Kalon	.18	0
Dera	.17	0
Mandi	.14	0

Source: Mehrauli survey.

* Low proportion of households owning livestock.

† High proportion of households owning livestock.

production does not correspond with seasonality of fluid-milk marketings. The low in production per household occurs in the rainy season, while the marketing low occurs in the winter. Products manufactured in the village households, rather than liquid milk consumption account for the dissimilarities. The interseasonal differences in fluid-milk marketings are greater than the interseasonal differences in buffalo milk production per household, for animals in milk. The opposite is true for cows (table 14). Seasonality of milk production is much less than was recorded in the 1953–55 IARS study.

These seasonal data again show the dominant role of buffalo in this region, which has been engaged for at least two generations in commercial fluid-milk production. Villagers have succeeded to a considerable extent in adjusting milk production to seasonal requirements of the urban community. The cycle-dudhia apparently is not engaged in procuring milk for manufactured products during the winter months. This adjustment is left to the village households.

While the achievements in adjusting production to seasonal demands are important, the concluding section of this chapter indicates that the response in productivity is even more important.

Marketing costs and returns in the cycle-dudhia system

Analysis of locational aspects of milk production and selling in Mehrauli block demonstrates the geographic limitation of the cycle-dudhia system. The most distant villages surveyed, and those served by the poorest "roads", were engaged in some seasons in milk sales through the cycle-dudhia system. As increasingly poor road conditions yield lower prices to the village household, milk utilization shifts from the fluid-milk market to the milk-products market.

The survey results in villages near the densely populated urban center indicate a decline in the number of households selling milk and in the number of dudhias operating. As Delhi continues to expand, consumers at the center will be forced to pay the higher costs of bringing milk from increasingly greater distances.

Table 13. **Prices for buffalo milk in zone 3 villages, Mehrauli, 1966–67**

	Bhatti	Mandi	Dera
	rupees per kilogram		
Summer	.810	1.025	.860
Rainy season	.760	.803	.750
Winter	—	.810	.772

Source: Mehrauli survey.

Table 14. **Average daily milk production and fluid sales by seasons, Mehrauli, 1966–67**

Milk production	Summer	Rainy	Winter
Per household:			
Buffalo	9.43	8.81	9.43
Cow	1.18	.54	1.01
Per milch bovine:			
Buffalo	5.42	5.66	6.20
Cow	1.78	.71	1.36
Per bovine in milk:			
Buffalo	7.92	7.20	7.77
Cow	3.71	2.19	3.03
Fluid sales per household	8.45	6.25	5.84

Source: Mehrauli survey.

Improved physical performance through equipment modernization is not difficult to demonstrate. To estimate how a change in technology might improve the economics of the traditional system it is necessary to determine the structure of costs.

Thirteen of the 135 milk-selling households interviewed were cycle-dudhias. An additional 5 cycle-dudhias who purchased milk from sample households also responded to an expanded questionnaire on marketing activities. Investment capital for the strictly random group was 558 rupees versus 343 for the 5. Daily hours of labor input also were higher for the random group, reflecting a higher number of multiple-bicycle operators.

In budgeting the cost of marketing within the dudhia system, data from 18 respondents were analyzed. Average daily households sales reported in villages served by dudhias and average daily purchases per village household were similar (table 15). Comparative household milk prices reported by the 18 dudhias were also similar. The household data probably represent the seasonality of price better than the dudhia data, which are limited.

Dudhias were classified into 3 groups on the basis of daily volume of summer receipts (table 16). As previously noted, 2 of the 12 villages included in the household sample did not sell milk to dudhias. Although households in Gadaipur, Bhatti, and Madan Garhi sold to dudhias, none of the dudhias who collected milk in these villages were interviewed.

The Mehrauli dudhia served 3 types of consumers: (1) the home consumer of fluid milk, (2) the city milk shop which sells fluid-milk (dudwala), and/or manufactures milk sweets (halwais), and (3) the dairy (milk separator operator) who purchases cream for ghee manufacture.

During the winter round of the survey, for which customer information is most complete, the 18 dudhias served 647 households, 8 halwais, and 4 retail milk peddlers. One dudhia admitted that he was selling to a separator

Table 15. **Household and dudhia reports of household selling price of milk and sales volume, Mehrauli, 1966-67**

	Daily average		
	Summer	Rainy	Winter
Household sales (kilograms):			
Dudhia report	12.5	7.0	8.3
Household report	11.9	7.4	7.8
Household milk price (rupees per kilogram):			
Dudhia report	0.902	0.833	0.839
Household report	0.939	0.807	0.839

Source: Dudhia and household surveys.

operator. One dudhia was selling to an engineering college and 3 were making sales to military canteens.

A total of 26 cycles were in operation. The average number of households serviced per cycle operator was 18. For the 14 dudhias who reported quantities of milk sold by customer categories, the daily average household sale was 1.4 liters, .7 liter per delivery. Although data on the distribution of milk sales among types of purchasers are incomplete, available data indicate that 35 to 40 percent of dudhia sales were to non-household consumers. Sales to institutions, such as schools or military establishments, and to halwais each constituted about 15 percent of total sales, the balance going to creameries or dudwalas.

The milk sold to separator operators and dudwala-halwais was probably homogeneous in physical if not in bacteriological quality. Milk sold to urban households frequently differs from the product purchased from village households, having undergone some alteration. It was not possible to determine by direct interview the extent to which the milk product was altered. Although the volumes of milk receipts and of milk sales were recorded separately, these differed little in the first season (summer) and not thereafter.

Although product accounting based on milk receipts and sales reported by the dudhias did not provide evidence to indicate skimming or dilution of fluid milk, a confidant who worked with the villagers (but not on the survey team) firmly stated that such practices were common. An approximation of milk dilution is suggested by a comparison of reported capacity (milk containers in use) and reported milk purchases. It is possible to adjust the carrying capacity of the cycle by varying the selection of cans used. Partially filled cans which result in churning normally would be avoided. The reported data on milk receipts and carrying capacity indicate an excess can

Table 16. **Classification of Dudhias by volume of milk purchases, Mehrauli, 1966–67**

Zone	Village	Daily volume		
		0–50	51–100	over 100
		kilograms		
1	(5) Hauz Rani	–	1	–
	(9) Mehpalpur	1	–	1
	(13) Rangpuri	1	–	1
2	(4) Ghitorni	3	3	1
	(12) Rajokri	–	–	1
3	(2) Dera	2	–	1
	(8) Mandi	1	1	–
Block		8	5	5

Source: Dudhia survey.

capacity in summer months. As a shortage of milk generally occurs in the urban Delhi market during the summer, consumers would be inclined to accept dilution during that period, rather than risk losing their supplier or paying higher prices. It is also possible that milk shortage results from skimming and failing to report cream sales. As both dilution and skimming are statutory violations, dudhias would be inclined to hide these activities. Costs of marketing are budgeted both on the assumption of no product alteration and with assumptions of alteration.

Data were collected on the milk marketing enterprise and on possible income supplementing activities. Dudhias might earn additional revenue by peddling consumer goods or production supplies acquired in the city to villagers. Results indicate that the incidence of this activity is limited to providing service to the dudhia family. Loans for the purchase of buffaloes were the most significant supplementary service reported.

In addition to providing credit for livestock purchases, dudhias frequently reported giving monthly advances to supplying households. Estimates of the cost of these services were subjective and, therefore, were excluded from the general budgets.

Table 17 shows the budget of incomes and expenditures per household and per dudhia, assuming no product alteration or credit services. The dudhia and household surveys provided data for determining the following operating activities:

Gross margin on sales. Seasonal average purchase and selling prices are computed for each of the 3 dudhia size categories. Prices used in this computation were provided by the dudhias. The price *margin* is applied to average daily milk purchases for each survey period. The average daily income figure is then used to estimate income for 1 season.

Table 17. **Budgeted dudhia incomes with assumption of no product alteration and no credit services, Mehrauli, 1966-67**

Average daily receipts (kilograms)	Size categories by daily receipts (kilograms)		
	0–50 27	51–100 64	Over 100 165
		rupees	
Capital investment (rupees)	344	427	814
Household averages (annual):			
Gross margin on sales	905	3,202	7,322
Depreciation on equipment	69	85	163
Repairs	132	180	360
Product losses	8	43	35
Wages	0	225	948
Net income	696	2,669	5,816
Annual income per participating dudhia	557	1,668	2,908

Source: Dudhia survey.

Depreciation of equipment. The major items of equipment were bicycles and various types and sizes of milk cans. Measuring ladles and burlap for wrapping cans contributed little to cost. Estimates of investment were obtained in both the summer and rainy seasons. For 8 of the 18 respondents, the estimate differed between seasons. These differences were due to variations in the valuation of equipment and number of cycle riders. Variation reflects non-sampling error resulting from subjective recall. Investment was taken as the mid-range of reported values. Most dudhias reported that a bicycle could be used for 5 or 6 years. With replacement of major parts, some cycles may be used for longer periods. Milk cans were of the type constructed by local metal shops; some were galvanized. In a hot dry climate, these cans have a life expectancy of many years. The expected bicycle life is taken as 5 years, the same as for cans.

Repairs. Most respondents had no clear idea of their expenditures for repairs. A few dudhias volunteered estimates. Since road conditions and quality of cycle tires makes some repairs inevitable, the estimates provided were taken to apply to all dudhias in proportion to the number of cycles operated.

Product loss. A list of questions on the nature and frequency of product loss was included in the survey. A report of large losses was expected, considering distances covered and lack of refrigeration. The reported losses, however, were negligible. Estimate of losses for each size category is the average for the group. Five of the 13 dudhias reported losses of their com-

plete load due to customer rejection, or bicycle accidents; this occurred once or twice in a year.

Wages. Those dudhias employing non-family members in distribution reported the monthly wage rate. These data were used to compute the average annual wage for each size category.

Dudhias included in the survey were also engaged in milk production. Earnings from the production enterprise are not estimated. That portion of hired labor engaged in dudhia operations is included in the budget. Dudhia's time spent in milk distribution is imputed to dudhia labor in estimating returns to capital and entrepreneurial services. Hours worked by hired labor are per the statement of the proprietor. Hours worked by the proprietor are based on his stated hours of departure and arrival for each of the 2 daily market trips. Other household members were engaged in the milk-production enterprise, but not in the dudhia operation. Each dudhia also spent time in milk collecting and milking animals in the households from which he purchased. This unrecorded labor input is offset to some extent by unrecorded leisure time taken away from the village, which is included in reported hours of labor in distribution activities.

Taking the average hourly wage paid to hired labor (Rs. 0.313) as payment to owner-operators for their labor, the annual returns per household for capital and entrepreneurial services are:

Daily volume (kilograms)	Rupees
0–50	−301
51–100	+823
over 100	+1830

In budgeting operations of the cycle dudhias, differences in costs and returns by size categories are emphasized. In the 0–50 kilogram category, many dudhias dropped out of the market for a season. Daily average of receipts varied sharply between seasons (table 18). Activity of large operators was comparatively less in the winter season. They are, no doubt, more adept at scheduling activities to take advantage of improved urban market conditions, which result from reduced summer milk supplies from the Delhi Milk Scheme.

Price margins revealed by the dudhia survey disclose some surprising aspects of pricing. Dudhias do not retain the benefit of higher summer prices, but pass these back, at least in part, to the household producer. Margins in summer months are no larger than those in winter months. In the rainy season the situation is mixed, with the middle size group increasing margins while the others reduce margins.

The income situation changes significantly if the possibility of altering fluid-milk sales by dilution or by skimming is considered. Data on excess capacity of containers indicate the amount of dilution in summer is about 20 to 25 percent, if some allowance is made for essential slack. There was

Table 18. **Seasonality in dudhia activities, Mehrauli, 1966–67**

	Size category (kilograms)	Summer	Rainy	Winter
Daily receipts (kilograms)	0–50	32.6	22.7	32.3
	51–100	82.7	50.0	63.4
	Over 100	211.2	148.8	142.6
Purchase price (rupees)	0–50	.857	.880	.823
	51–100	.947	.786	.845
	Over 100	.880	.820	.854
Selling price (rupees)	0–50	.971	.983	.962
	51–100	1.113	.977	1.101
	Over 100	1.013	.900	1.035
Margins (rupees) ..	0–50	.114	.103	.139
	51–100	.166	.191	.165
	Over 100	.133	.080	.181

Source: Dudhia survey.

no dilution in the rainy season and possibly 5 percent in winter. As milk prices declined in the rainy and winter seasons, cream separation probably increased.

A number of dairies and shops that purchased cream were observed at various locations in Mehrauli block. Occasionally one of the dudhias interviewed was seen at these shops. Only one dudhia reported a sale to such a shop.

Although data could not be obtained on the nature of the cream separation activity, persons familiar with the dairies described the operation. About one-half of the milk collected by the dudhia is run through a hand separator operated by the dairy. The skim milk is mixed with the remainder of the whole milk and the dairy purchases the cream. Assuming cream is 40 percent butterfat and milk is 6.5 percent butterfat (allowing for the addition of cow's milk), the volume of milk for fluid-sale is reduced by 8 percent; the remaining fluid-milk would have a butterfat content of 3.5 percent. This process is identical to toning, dilution of whole milk with reconstituted non-fat dry milk by bottling plants, during the months of lowest milk receipts.

The price of ghee in Mehrauli for 1966–67 was 10 to 11 rupees per kilogram. The butterfat content of a kilogram of cream containing 40 percent fat would be worth 4 to 4.4 rupees. If it is assumed that cream sold to dairies is used in ghee production, Rs. 3.50 would be a reasonable selling price for the dudhia.

By separating one-half of his milk purchases, a dudhia carrying 80 kilograms per day gains Rs. 22.40 in cream sales and loses Rs. 6.40 in milk sales, for a net gain of Rs. 16 in total sales. If fat reduction resulted in a consumer price reduction of Rs. 0.10 per kilogram, the net gain would be Rs. 8.64 per day.

The extent of cream sales by dudhias is a matter of speculation. About one-fifth of the dudhias report selling prices of less than Rs. 0.90. This may be an indication of the proportion engaged in selling cream.

The budgeted dudhia incomes in table 17 assumed no product alteration. To understand the income effects of product alteration under the Mehrauli marketing circumstances, gross incomes are rebudgeted under 3 sets of assumptions:

Alteration A. All dudhias dilute milk with water to the extent of 20 percent of sales in summer and 5 percent of sales in rainy and winter seasons. Twenty percent of dudhias engage in separating 50 percent of receipts during rainy and winter seasons.

Alteration B. All dudhias dilute milk with water to the extent of 20 percent of sales volume in every season.

Alteration C. All dudhias engage in separating one-third of receipts during each season.

These assumptions are not supported by actual data. The dairies of Mehrauli might have been persuaded to provide some information on skimming. They were not contacted, however, because word of such inquiries might have been passed to the dudhias. In such event all cooperation on the part of dudhias would have terminated, as they were extremely wary of the possibility of official inquiries into their activities.

Prices used in budgeting returns from milk alteration activities are those quoted by the dudhias. In each case it is assumed that these prices reflect the existence of the particular activity hypothesized. Changes in income reflect the effect of alterations in volume and form of sales.

Budgeted incomes suggest product alteration is an essential practice for the small operator and a profitable one for the large operator (table 19). The extent of these practices may not be uniform across size categories. The larger operator may supply customers who demand a higher standard of performance. This is probably true for the suppliers of military establishments.

If the behavior of the small-scale private operator is consistent with observed behavior of small-scale farmers in either the United States or India, then it may be that the budgeted negative incomes do not suggest product alteration. The operators may simply be working at a return which is below the opportunity cost of their labor input.

Under the assumptions regarding the operation of the cream selling activity, traditional toning brings higher returns than dilution with water and

Table 19. **Budgeted dudhia incomes assuming product alteration but no credit services, Mehrauli, 1966-67**

	No alteration	Product alteration*		
		A	B	C
	rupees per year			
Small:				
Gross	905	1,216	1,132	2,007
Net per dudhia	557	806	738	1,438
Returns to capital and management assuming dudhia hourly wage.				
Rs. 0.313	−301	− 52	−120	580
Rs. 0.250	−129	120	52	752
Medium:				
Gross	3,202	4,079	4,003	5,963
Net per dudhia	1,668	2,216	2,169	3,393
Returns to capital and management assuming dudhia hourly wage.				
Rs. 0.313	823	1,369	1,324	2,546
Rs. 0.250	992	1,540	1,493	2,717
Large:				
Gross	7,323	9,707	9,154	15,811
Net per dudhia	2,908	4,101	3,824	7,153
Returns to capital and management assuming dudhia hourly wage.				
Rs. 0.313	1,830	3,023	2,746	6,075
Rs. 0.250	2,047	3,240	2,963	6,292

Source: Dudhia survey.

* A = Dilution and separation as suggested by survey findings.
B = 20 percent dilution of all sales.
C = One-third of all milk receipts separated.

provides the fluid-milk customer with a greater quantity of non-fat solids for his expenditure.

The extent and nature of the alteration of milk prior to sale, based on the analysis of excess capacity indicated by the dudhia survey, can be taken only as a general indication of this activity. As noted, product accounting did not reveal evidence of product alteration after the first season of the survey. It is conceivable that the dudhias were aware of the significance of the inventory of cans in use by the second and third rounds of the survey.

The extent to which labor and management charges dominate other marketing costs in the cycle-dudhia system is evident when costs are presented on a unit basis (table 20). Labor charges (including dudhia labor imputed at Rs. 0.313 per hour) constituted 84 percent of total costs; this percentage varied by only 1 percent between size categories.

Table 20. **Cost per kilogram of marketing whole milk in the dudhia system, Mehrauli, 1966–67**

Elements of cost	Daily volume (kilograms)		
	0–50	51–100	Over 100
	rupees per kilogram		
Depreciation	.009	.005	.003
Repairs	.018	.010	.006
Milk losses	.001	.002	.001
Wages (hired)	0	.012	.017
Wages (household)	.143	.072	.038
Total cost	.171	.101	.065

Source: Dudhia survey.

Reduction in depreciation costs resulting from the scale of operations was not significant, reflecting the low investment and divisibility of the units of capital equipment. One-third of the investment was in milk cans, the remainder in cycles.

Returns to size of enterprise are evidenced by the decline of 38 percent in unit marketing costs from small- to large-scale operators. Greater efficiency was achieved by more intensive use of the same factor combinations. Lower unit costs were a function of greater efficiency in the use of specific technological inputs to management and labor. The volume of milk handled per man hour of labor input was more than twice as great for the largest size category. Earnings per hour of labor input increased 250 percent. Daily hours worked per dudhia increased only 29 percent from the smallest to the largest size categories (table 21).

The average investment for the largest dudhias was Rs. 814. This capital, if invested in lending operations, would return a minimum of Rs. 81 per annum. The capital cost per kilogram of sales is Rs. 0.0015. The equivalent cost is Rs. 0.0023 for medium size dudhias and Rs. 0.0045 for the small operators. The absence of general participation by villagers in the organized money market makes these estimates highly speculative.

Comparison of estimated marketing costs and marketing margins reveals the cost per unit for major management services, including risk-taking, and for capital services (table 22). The negative return to small operators is likely to be due to their valuation of labor services below the budgeted rate of Rs. 0.313.

Effect of market access on production and marketing activity

The 1953–55 IARS study of cost of milk production in Delhi state included 54 stables in the urban area and 96 stables (households) in 24 vil-

Table 21. **Labor productivity in the Mehrauli cycle-dudhia system, 1966–67**

Size category (daily kilograms)	0–50	51–100	Over 100
Proprietary dudhia labor (daily hours)	9.39	11.85	19.35
Daily hours per dudhia	7.51	7.40	9.68
Hired labor input (daily hours)	0	.75	7.32
Total labor input (daily hours)	9.39	12.50	26.67
Earnings of proprietor and wager (daily rupees)	1.91	7.93	18.53
Earnings of proprietor and wager (hourly rupees)	.20	.64	.69
Daily volume of whole milk marketed (kilograms)	27.0	64.0	165.0
Volume per man hour (kilograms)	2.9	5.4	6.3
Volume per man day (kilograms) ..	23.2	43.2	50.4

Source: Dudhia survey.

lages in the suburban area. Six of the suburban villages are in the Mehrauli block, which was estimated to produce 26 percent of the total rural supply at that time. Investigators made weekly visits to these 150 stables (households) for a 2-year period.

Although the area covered by Delhi and New Delhi has expanded rapidly in the last decade, villages which were classified as suburban by the IARS study would still be classified as suburban (23, p. 8). All of the 6 suburban villages in the 1953–55 Delhi study are farther from residential areas than the villages of zone 1 in the Mehrauli study that engage in direct fluid-milk selling. The suburban villages of the IARS study are, therefore, equivalent to rural villages of the Mehrauli survey in terms of proximity to market.

The IARS publications do not give results separately for different regions of the state. Results of the study, however, show no significant variation in the cost of production among villages in Delhi (23, p. 13). Soil and water resources of the Mehrauli block area are generally inferior to those in the rest of Delhi territory. This suggests that Mehrauli has milk-producing livestock equal to that in areas of Delhi territory.

A 1964 study of selected villages of Delhi where milk production was known to be highly commercialized, also indicated that inter-village differences in marketings per household were small. The 1966–67 marketing results for the summer season in zone 1 of Mehrauli were equivalent to per "subsidiary" milk producer marketings. Selected "primary" milk producers were indicated to be marketing quantities comparable to the larger producer-dudhia in Mehrauli. Neither villages nor stables were selected at random in the 1964 study. This study was specifically designed to obtain information on milk selling activity near proposed Delhi Milk Scheme procurement centers (15).

Table 22. **Marketing costs and margins for the dudhia marketing system, Mehrauli, 1966–67***

Daily volume (kilograms)	0–50	51–100	Over 100
Cost	.171	.101	.065
Margin	.119	.174	.131
Residual	–.052	.073	.066

Source: Dudhia survey.
* Assuming no adulteration.

The dudhias serving Mehrauli producers in 1966–67 sell in areas of New Delhi having higher than average incomes. Many of the areas consist of public housing projects for employees of the government of India. Given the physical limits on the capabilities of the dudhia system it seems likely that in 1953–55 Mehrauli also served primarily the New Delhi area. The population of New Delhi has more than doubled in the intervening 12 years.

It is not possible to state conclusively how representative Mehrauli is of Delhi territory. It is unlikely that the Mehrauli represented by the 1966–67 survey is more commercialized than rural Delhi as a whole, than was Mehrauli as represented in the 1953–55 IARS study. This is because the 6

Table 23. **Average number of milch animals per household, rural Delhi, 1953-55: Mehrauli, 1966-67**

Date	Locality	Milch cows		Milch buffaloes		Buffalo proportion
		Inventory	Percent in milk	Inventory	Percent in milk	
Summer:						
1953–54	Delhi	.74	43.2	1.03	56.3	.58
1954–55	Delhi	.69	49.3	.91	57.1	.57
1967	Mehrauli	.91	39.2	1.81	66.4	.67
Rainy season:						
1953–54	Delhi	.75	41.3	1.02	58.8	.58
1954–55	Delhi	.71	52.1	.95	57.9	.57
1966–67	Mehrauli	1.06	29.0	1.66	76.7	.61
Winter:						
1953–54	Delhi	.74	29.7	.88	72.7	.54
1954–55	Delhi	.72	45.8	.93	77.4	.56
1966–67	Mehrauli	1.20	39.3	1.74	76.5	.59

Source: Delhi data are from (23, p. 71.)
1966–67 data are from Mehrauli survey.

Table 24. **Average daily yields per milch animal — rural Delhi, 1953–55 — Mehrauli, 1966–67**

Bovine and locality	Date	Summer	Rainy	Winter	Annual
		kilograms			
Cow:					
Delhi	1953–54	1.07	1.40	.75	1.03
	1954–55	1.40	1.36	1.05	1.26
Mehrauli	1966–67	1.78	.71	1.36	1.28
Buffalo:					
Delhi	1953–54	1.70	3.52	4.05	3.04
	1954–55	2.45	3.07	4.20	3.26
Mehrauli	1966–67	5.42	5.66	6.20	5.73

Source: (23, p. 70) and Mehrauli survey.

villages selected in the IARS study do not include any from zone 3 of the 1966–67 study. Thus, comparisons of production and marketing activity of Mehrauli in 1966–67 with Delhi in 1953–55 are not likely to overestimate improvements in time (table 23). This comparison indicates the number of buffaloes nearly doubled by 1966–67, and the proportion of buffaloes in milk increased in the summer and rainy seasons. The proportion of cows in milk appeared to be lower in the summer and rainy seasons, although the number increased. Whereas milch buffalo constituted 54 to 58 percent of milch animal inventories in 1953–55, they constituted 59 to 67 percent in 1966–67.

Increase in the proportion of lactating buffaloes per household was accompanied by increased milk yields (table 24). Average daily yield in 1953–55 of milch buffalo in urban stables (95 percent in milk) was less than average daily yields per lactating buffalo in Mehrauli in the summer. It was

Table 25. **Average daily buffalo milk production* — Delhi, 1953–55 — Mehrauli, 1966–67**

Locality	Date	Summer	Rainy	Winter	Annual
		kilograms			
Urban Delhi (per milch buffalo)	1954–54	7.18	6.88	7.64	7.28
	1954–55	7.33	7.62	7.77	7.57
Mehrauli (per buffalo in milk)	1966–67	7.92	7.20	7.77	7.63

Source: (23, p. 67), and Mehrauli survey.

* 95 percent of urban milch buffaloes in milk.

similar in the rainy and winter seasons of 1966–67. Rural yields in 1966–67 equaled urban yields of 1953–55 (table 25).

Comparison of yields per buffalo and per cow indicate the relative importance of the cow diminished sharply (table 24). Little decline occurred in buffalo yields during the summer in 1966–67, whereas the decline in 1953–55 was significant. Seasonal differences may be influenced by the periods of observation, as they lag the seasonal periods of the IARS study, especially in the rainy season.

In the IARS study, rural milk-producing households were also classified as commercial or private; the results were presented separately. Comparison of commercial milk production on an annual basis for rural Delhi, 1953–55 and Mehrauli, 1966–67, indicates only a slight gain in the comparative 1953–55 production level (table 24 and table 26). Commercial households in 1953–55 compare with zone 3 households in 1966–67. Yields in zones 1 and 2 are more comparable to urban yields in 1953–55.

Comparisons of 1953–54 and 1966–67 data indicate that substantial progress has been made in increasing productivity in the dairy livestock sector of Delhi territory. Increased milk production has been achieved through changes in livestock management practices and not through the emergence of specialized dairy farms. This suggests that, given improved market access, substantial increases in milk production may be achieved even though milk production remains a subsidiary enterprise. The comparison also supports the contention that the cow is being replaced by the buffalo as a commercial dairy animal (31, p. 16).

Table 26. **Average daily buffalo milk production, Mehrauli, 1966–67 — rural Delhi "commercial" 1953–55**

	Per buffalo in milk	Per milch buffalo
	kilograms	
Mehrauli, 1966–67:		
Zone 1	8.31	7.19
Zone 2	8.56	6.07
Zone 3	5.16	2.53
Block	7.62	5.56
Delhi:		
Commercial cultivator 1953–54	5.11	3.60
1954–55	5.58	3.93
Commercial non-cultivator 1953–54	5.12	3.28
1954–55	4.31	3.10

Source: (23, p. 92) and Mehrauli survey.

Chapter 4.

Modern Fluid-Milk-Marketing Systems in India — Case Studies

The research objective in the modern sector was to assemble data for budgeting cost of marketing services and to explore technical capabilities of the system. Because the consumer market and resources committed to dairy production differ widely among the communities in which modern milk-processing plants have been established, it was decided to make intensive studies of several plants operating under different marketing conditions and to visit as many additional facilities as the work schedule permitted. Observation of milk procurement activities in the modern systems could document variability in milk production conditions not obvious in the regionally confined traditional market study.

Selection of milk-processing plants and implementation of case studies

The plants studied were selected on the basis of sizes and types of systems representative of the modern milk marketing industry. The duration and intensity of research at each plant was determined by the degree of access to records, the quality of records maintained, and the complexity of the operation. The limiting factor was the quantity of information available. Where access to records was not significant, the research consisted primarily of interviews with plant officials and observation of procurement, processing, and distribution activities.

Considerable information was obtained with the help of the director of the Dairy Development Division of the Ministry of Agriculture, leaders in the cooperative sector, the UNICEF and FAO organizations, and the cooperation of plant management.

Six fluid-milk processing plants made their records available for study. Five were in the public sector and one was cooperatively owned. The geographically dispersed plants vary in size, product line, and distribution and procurement systems.

Informal visits were made to 8 additional dairy plants of various types throughout India. Two of these manufacturing plants in the cooperative sector also engaged in supplying bulk fluid-milk to urban bottling plants. One was a dairy-products plant in the private sector. The remaining 5 were primarily fluid-milk processing plants in the public sector, 2 of which were operated by the National Dairy Research Institute.

Formal cost accounting systems were not maintained by any of these plants. However, each public sector plant maintained a set of single entry financial accounts, which were audited on a regular basis by governmental agencies.

At each of the 6 "case" plants, financial and internal control records were reviewed for the following information: physical capacity of plant and equipment; investment in plant and equipment; type and volume of milk processed and product lines; cost of milk purchases; miscellaneous operating costs; revenue from sales; employment levels, job assignments, and wage rates; schedule of plant operations; procurement and distribution routes; purchase and selling price for milk and milk products; maintenance costs.

Additional detailed information on the procedure of plant operations and product flows was obtained by interviewing plant personnel. Data were collected on the seasonality of milk purchases and sales, purchase and selling prices, and operating costs.

Plants in operation for a number of years usually had developed a fairly extensive set of financial records and records for internal control. In several plants it was necessary to obtain information from summaries and material provided by plant management because of limited access to basic accounting records or poorly kept records.

Characteristics of case-study plants

Location of plants

Case-study plants are geographically dispersed in various-sized communities. In the discussion these plants will be referred to by letter designations (table 27).

Regions from which each of the plants draw their milk supplies have various resources for dairy production. Plants A, B, and E were located in regions with superior breeds of milking buffalo. Plants C and F processed primarily cow's milk, from both domestic Indian breeds and from crosses between these and western breeds. Cows in these 2 regions represent better than average stock for India. Plant D is in a region having relatively poor milk producing cattle and buffalo.

Plants were located in regions that had relatively high rainfall or irrigation facilities, with the exception of plant D, which was in an area deficient in water resources.

Each of the plants was located in commercial and industrial urban centers with a broad spectrum of income groups and rapid population growth.

Size of operation and capital investment

Plant size generally varied with community size, each community having one locally situated fluid-milk plant. The north India plant, A, with de-

Table 27. **Basic characteristics of case-study fluid-milk bottling plants, India, 1966–67**

Plant designation	Region*	Urban population†		Daily capacity*	Sector*
		1951	1961		
		thousands		liters	
A	North	1,191	2,224	300,000	public
B	West	788	1,150	60,000	"
C	South central	779	1,094	60,000	"
D	Central	120	185	10,000	"
E	Gangetic Plain	334	462	6,000	"
F	Southwest	198	286	10,000	coop.

Sources *Plant surveys.
† Statistical abstract of the Indian Union, 1965 (10, pp. 24–26).

signed capacity of 100 thousand liters per day, was the largest plant studied. Plants B and C in west and south central India had a capacity of 60 thousand liters. Plants D and F in central and southwest India had a capacity of 10 thousand liters and plant E in the Gangetic Plain was rated at 6 thousand liters per day. These capacity ratings assume a one-shift processing and bottling operation, and twice-a-day milk receipt and dispatch (table 27).

Although all of the case-study plants made extensive use of western dairy technology, the structure of investment varied substantially (table 28). This is traceable in part to differences in the mode of operation and in part to valuation problems. The 10,000-liter processing unit at plant F was installed in an old structure long owned by the cooperative. Buildings valued at acquisition cost contributed little to capital investment. Plant D, with a similar processing unit, had a large investment in motor vehicles and milk distribution booths. Plants E and C both had large investments in vehicle maintenance facilities and employee housing, which the smaller plants did not have. The structure housing large processing units was much more expensive than that employed in the smaller (and generally older) plants of 6 and 10 thousand liter capacity. Investment in procurement vehicles was limited in Plant B, because milk-supplying cooperatives transported by hired truckers, and only milk purchased from other processing plants was transported by the dairy. At Plant C, the entire procurement system was owned by the public dairy; it included 4 chilling centers, representing an investment of 826,000 rupees.

Differences in land investment were due in part to the date of purchase and in part to purchases anticipating future land needs. Plant B, for example, located within the densely populated part of the city, was built on a

Table 28. **Capital investment in case-study plants, India, 1966–67***

Item	Plant					
	A†	B	C	D	E	F
Daily capacity (thousand liters)	300	60	60	10	6	10
	thousand rupees					
Machinery and equipment	11,659	2,888	4,303	465	331	
Land	2,559	30	250		51	
Milk distribution booths	483	54	36	760		
Buildings	9,123	3,385	6,504			
Furniture and fixtures	253	224	30		296	
Milk crates and cans	837	172	26	272		
Vehicles	3,775	445	1,203		145	
Total investment	28,689	7,198	12,352	1,497	823	1,300
Investment per liter of daily capacity (rupees)	96	120	173	150	137	130

Source: Plant surveys.
* Investments are at acquisition value.
† Investment in 1963–64 for plant A and in 1965–66 for others.

relatively small plot of municipal land. Plant C was built on a large plot of land purchased in 1960 from private sources. The land value had doubled each year since the date of purchase.

Ownership and management

All of the case-study plants except plant F were publicly owned and operated. Plant F was owned and operated by a federation of producer cooperatives.

The public sector plants were financially integrated with the state or other political subdivision responsible for operation. Revenue was submitted to the public treasury and disbursements had to be approved by the treasury and/or by the governmental agency responsible for operation of dairies.

Management of the public dairies and other personnel were public employees and usually members of labor unions encompassing state employees. Some plant managers were career civil-service personnel; others were trained in dairy science or engineering and had substantial experience in the dairy industry.

The chilling centers associated with each plant were generally owned and operated by the public sector. However, one of the chilling centers supplying plant B and one supplying plant A had been transferred to a cooperative by the public authority.

Marketing facilities and functions

Milk assembly. Milk procurement systems varied among plants and differed from systems in western countries. The smaller public dairies (C, D, E) received milk only in cans. Most of the milk was not cooled from the time of milking in the village until receipt at the plant, necessitating rapid and reliable transport equipment. An enclosed van on a standard one and one-half ton truck chassis was used to procure milk from villages 10 to 30 miles distant.[7] Milk was not purchased from households within the urban center or adjacent villages.

In addition to receiving uncooled milk from villages, the larger dairies (A, B, and C) received cooled milk through chilling centers located as far as 60 miles from the plant.[8] Each chilling center had the capacity to chill and hold 10 to 15 thousand liters of milk with one daily transfer to the urban plant. Procurement from the villages was either once or twice a day. In areas where small quantities of milk were received from each village, the milk from only one milking was purchased.

It became evident in the course of plant survey work that a particular type of institutional arrangement was being promoted by the central government of India. This preferred type of public sector marketing system for fluid-milk is shown schematically in figure 5. The basic motivation in promoting this organization is to exclude the traditional milk marketing agents (12, p. 202). Ultimately, only one ownership transfer would take place in the entire marketing process, that of urban consumers purchasing milk directly from facilities owned and operated by federations of milk producer cooperatives.

Management of the public case-study plants has had varied success in implementing public policy in milk procurement operations. Difficulties have been encountered in organizing milk producer cooperatives; they are due in part to caste or clan factionalism within village communities, and in part to a price policy which has provided inadequate incentives. When management has been unable to organize effective producer cooperatives, village residents have been employed to assemble and test milk.

Failure to expand milk supplies has forced employment of traditional marketing agents who have the initiative to engage in successful milk collection. Two types of private agents assembled milk for public sector chilling centers. Cycle-dudhias delivered milk from villages near the chilling

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[7] Plant D had recently installed a farm tank (ice bank type) in a village 50 miles distant.

[8] In the unique case of the Bombay Milk Scheme, households at a distance of 275 miles were served through the procurement system of the AMUL milk product factory at Anand. Milk was transported by rail from Anand to Bombay. The public sector plant at Delhi was contemplating the rail transport of milk from Bikaner in Rajasthan (a distance of 240 miles), if sufficient milk could be procured in that region.

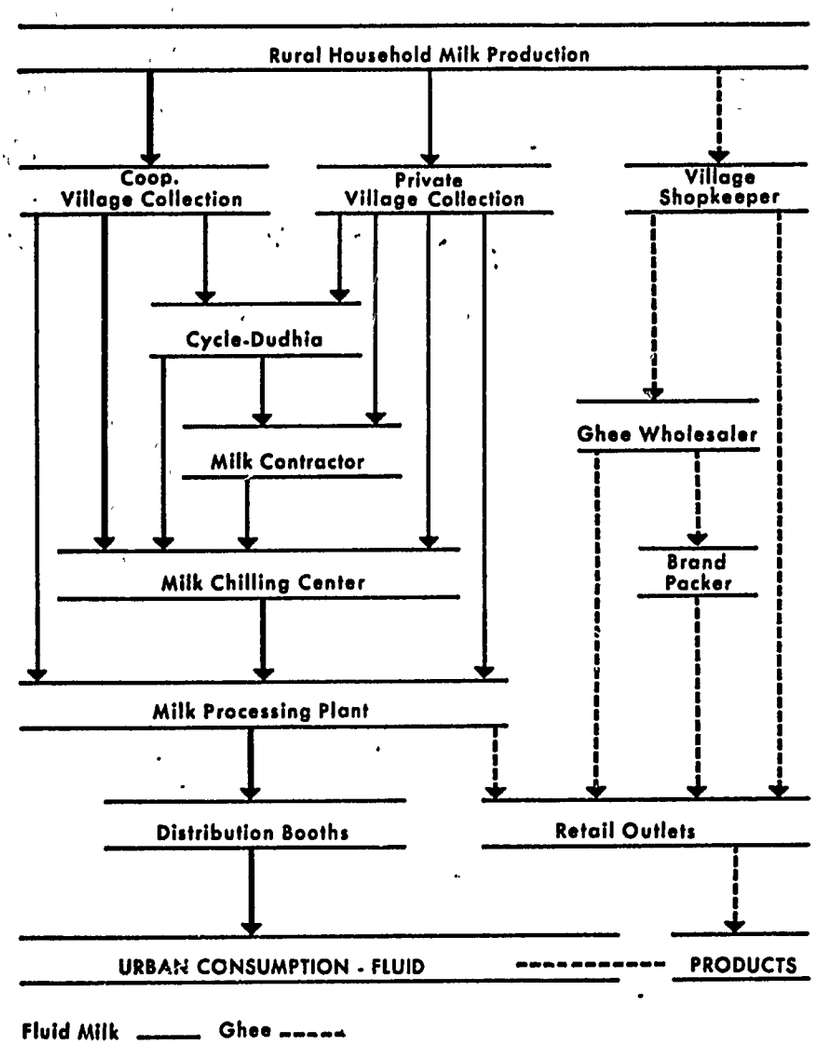

Figure 5. **Diagram of modern milk-marketing channels, India, 1966–67.**

center; milk from more distant villages was assembled by operators of private motor trucks who contracted with the dairy to supply specific quantities of milk. The "contractors" established their own system of assembly from individual villages.

Plant B in western India had established a procurement system that con-

formed with public policy. The urban dairy purchased milk from several district federations of village cooperatives.

Milk procurement at the cooperatively owned and operated plant F differed somewhat from the general pattern described for public dairies. Milk purchases were from local cooperative members only. Milk from nearby villages was transported in part by cycle and in part by motor vehicle. One chilling center with a surface cooler was operated by a village cooperative located 30 miles from the city. These coolers are fairly common in India — a product of the military-dairy-farm era during British rule (8, p. 140). Plant F also purchased milk from urban cooperative members. The cooperative operated a milking parlor adjacent to the dairy, to which urban producers brought animals for milking.

Milk purchases. Buffalo milk was the dominant source of supply at case-study plants which recorded cow and buffalo milk receipts separately (table 29). The proportion of cow's milk being processed at some plants is declining. The decline may be more significant than the data suggest, as skimmed buffalo milk was occasionally purchased as cow's milk. Tests for the detection of mixed milk were not common, and dairies frequently paid for mixed milk without attempting to identify the content.

Equipment. Milk pasteurizing and bottling plant equipment, the basic element in all the case-study processing systems, was manufactured in European or Commonwealth nations. The bottles and aluminum foil strip used in bottle capping machines were manufactured in India. Each bottling line included an automated bottle washer.

Plants were equipped with either automated or manual bulk-can fillers. Cans used in distribution were either tinned metal of Indian manufacture or insulated aluminum of foreign manufacture.

Dump and weigh tanks were employed at each plant for receiving milk in cans. Either rotary or straight-through can washers were in use. Plants A, B, and C also were equipped to receive milk in bulk road tankers.

Steam generally was supplied by coal-fired boilers of American manufacture. Plant C, however, was equipped with oil-fired boilers.

Refrigeration requirements at the 5 public plants consisted of ammonia compressor–ice bank systems commonly used in milk plants of western countries. This unit provided ice water for milk chilling and for diffusers in cold-storage rooms.

Milk storage within the plant was in insulated stainless steel tanks of various sizes and types. Most were imported, although such tanks are now made in India.

Many plant buildings were the most modern that dairy engineers design. Buildings were multistoried reinforced-concrete structures, incorporating sanitation features in areas where milk is handled. In-place cleaning of the internal milk-transport system was standard.

The dairy buildings were constructed by the public works branch of the operating governmental sector. These public agencies influenced the design

Table 29. **Milk purchases at case-study plants, India, 1962–66**

Plant	A		B		C†		D‡		E§		F	
	000 l.	%	000 l.	%	000 l.	%	000 l.	%	000 l.	%	000 l.	%
1962–63:												
Cow	1,896	4	1,325	16	—	—	—	—	—	—	1,823	50
Buffalo	42,994	96	7,004	84	—	—	—	—	—	—	1,844	50
Total	44,890	100	8,329	100	—	—	—	—	—	—	3,667	100
1963–64:												
Cow	2,060	4	1,062	15	—	—	—	—	—	—	2,203	50
Buffalo	46,271	96	6,016	85	—	—	—	—	—	—	2,186	50
Total	48,331	100	7,078	100	—	—	1,176	—	—	—	4,389	100
1964–65:												
Cow	1,058	3	1,102	13	—	—	—	—	—	—	1,854	44
Buffalo	37,954	97	7,100	87	—	—	—	—	—	—	2,378	56
Total	39,012	100	8,202	100	—	—	1,301	—	1,020	—	4,232	100
1965–66												
Cow	1,631	3	1,443	16	—	—	—	—	—	—	1,459	36
Buffalo	50,009	97	7,602	84	—	—	—	—	—	—	2,642	64
Total	51,640	100	9,045*	100	2,819	—	1,525	—	1,163	—	4,101	100

Source: Plant surveys.

* Additional standardized milk purchases of 4,090 thousand liters.

† Mixed milk testing 3.5–3.8, mostly cow's milk.

‡ Mixed milk, mostly buffalo.

§ Mixed milk testing 6.4–6.5, mostly buffalo.

of the structure, particularly the external architectural appearance. The basic engineering design was usually laid out by national or international agencies, which donated the processing equipment (15). Equipment was installed by Indian subsidiaries or agencies of European dairy equipment manufacturers.

With the exception of plants E and F, all processing equipment was operational and in use. At plant E the bottling line was in disrepair and had been dismantled. Bottling was performed by hand-submerging bottles in milk cans. Bottle washing also was by hand. The bottling unit in the cooperative plant F was inoperative due to the absence of a water softening unit for treating the available well water. Only chilling and pasteurizing equipment was in use. Plant F was unique in that it employed a freon refrigeration unit.

Fluid product lines. The liquid-milk product line varied considerably among plants (table 30). The major difference was the level of milk fat standardization. Toned milk contained 3 to 3.5 percent fat, double toned milk about 1.5 percent, and buffalo milk 6.5 percent. The standardized milk at plant B was 4.5 percent butterfat.

A major factor influencing the type of fluid milk sold was the governmental concept of the legitimate functions of the public sector dairy. Low consumer price was a major objective of each dairy. As neither state governments nor the central government were fully committed to public subsidization of milk consumption, each public sector dairy had to find ways of reducing the cost of the product while increasing availability. Skim milk powder was used with buffalo butterfat to produce toned milk products. Generally, the procedure was to reconstitute skim powder in a mixing vat; this was used to standardize high fat buffalo milk down to 1.5 to 3.5 percent butterfat. The non-fat solids content was not altered by this process. The toned milk was then pasteurized and either bottled or placed in bulk cans.

Availability of non-fat dry milk, donated by various national and international agencies, has facilitated the practice of toning. The level of these donations has fluctuated sharply in recent years, creating instability in plant operations. Foreign exchange shortages make it difficult to compensate for fluctuations in powder donations through purchases in the world market. Domestically produced skim powder in India cost the fluid plant about 6 rupees per kilogram, compared to 2 rupees for imported powder. The high domestic price of powder was due in part to idle plant capacity. With the exception of the Kiara milk products plant at Anand, product plants in India were operated at 25 to 40 percent of capacity on an annual basis (33). In the absence of skim powder, some plants continued extensive toning by extracting butterfat from milk receipts. The policy at plant B was to increase the quantity of higher-fat milk distributed.

The type of milk purchased by dairies also influenced the fluid product mix. In regions where cows were dominant rather than buffaloes, the fat

Table 30. **Sales volumes by product line at case-study fluid-milk plants, India, 1965–66**

Product line	Plant					
	A§	B	C‡	D	E	F¶
	liters (thousands)					
Liquid milk:						
Buffalo:						
bulk		274	†			2,492
bottled		1,479	†		824	†
not specified	35,455			1,399		
Toned:						
bulk		1,075	†		†	†
bottled		156	†	†	†	†
not specified	18,368					
Cow:						
bulk	858	3		†	†	1,438
bottled		180		†	†	†
not specified			2,022			
Double toned:						
bulk		1,251		†	†	†
bottled		†		†	†	†
not specified	4,371		1,564			
Standardized:						
bulk	†	4,029	†	†	†	†
bottled	†	7,754	†	†	†	†
Sterilized	*	†	†	†	†	†
Skim (fresh)	†	*	17	†	†	†
Skim (sour)	†	254	†	†	†	†
Flavored	†	6	†	†	†	†
Total fluid product	59,052	16,461	3,603	1,399	824	3,930
Daily sales volume	161.8	45.1	9 9	3.8	2.3	10.8
	kilograms (thousands)					
Manufactured products:						
Cream	*	*	†	†	†	†
Butter	399[11]	26	9	**		4.7
Ghee	520[11]	32	1	**		*
Casein	†	†	†	†	†	7.2
Skim milk powder	227[11]	†	†	†	†	†
Whole milk curd	†	†	†	†	†	*
Skim milk curd	†	†	†	†	†	2.0
Cooking butter	†	†	†	†	†	*
Buttermilk	†	†	†	†	†	4.7
Ice cream	*	†	†	†	†	*
Khoa	†	†	†	†	†	2.6

Source: Plant surveys.
* Minimal quantities.
† Not in product line.
‡ Mostly bulk distribution; bottling started Oct. 1965.
§ Most milk is bottled.
[11] Production.
¶ 1964–65 product sales.
** Not available.

and solids content of purchased milk generally was not altered before sale. Toned milk at plants in these regions had only 1.5 percent fat. Many Indian consumers prefer cow's milk and it was frequently handled separately, even in regions where buffalo's milk was dominant.

Although low-fat milks had been successfully introduced in some communities, the success of the 4.5 percent "standardized" milk introduced by plant B suggests that there may have been consumer resistance to low-fat milk. Dairy B was located in a region where buffaloes predominated as dairy animals.

Two of the 5 public-sector plants (B and C) were UNICEF-assisted. In return for furnishing milk-processing equipment, UNICEF required the assisted dairies to supply milk at low prices to specific consumers such as school children, nursing mothers, hospitals, etc. This obligation extended over a 10-year period and the value of the milk distributed had to equal a contracted percentage of the value of donated equipment. Minimum standards were set for SNF and butterfat content of the milk and plants were penalized for supplying milk below the minimum fat content.

Plant A was engaged in the packaging of sterile milk and plant B was installing a sterile-milk-bottling line. These milks were flavored and then sterilized in the bottle. This product was a luxury food item and represented an effort on the part of the dairies to supplement earnings through distribution of a product to high income consumers. It also constituted an experiment in distribution methods.

Distribution containers. Each public-sector plant distributed milk in glass bottles and also in bulk containers. Both 200 and 500 milliliter bottles were in use. The 500 milliliter bottle was most commonly used in delivery to households. Deliveries to schools were occasionally in 200 milliliter bottles, but there seemed to be a shift to bulk deliveries to schools.

There is a substantial food processing and packaging industry in India directed at relatively high income groups. The motive for introduction of consumer packaging in a market is usually to insure the quality of the product and convey to the purchaser a distinctive identity. The primary motive for introducing consumer packages of milk in India was to insure that the product would not be diluted. The glass bottle was used because it was available from domestic sources and made dilution of milk more difficult than when milk is dipped from cans into the consumer's vessel. Precautions are still needed to insure against adulteration.

Manufactured dairy products. Public sector plants manufactured milk products as a means of using by-products of the fluid-milk operation. Cream removed in standardizing butterfat content of milk was processed into ghee and butter. Those products were produced in large quantities by plants receiving buffalo's milk (table 30). A small quantity of roller-dried skim milk powder was manufactured by plant A. Although ghee prices were rising steadily, butter stocks accumulated in the larger dairies (35, p. 281). Indian dairy economists point out that buyers will not accept irregular supplies of butterfat from fluid-milk plants (28, p. 285). Anticipated rise in prices might provide an explanation for accumulated stocks of ghee and butterfat.

The cooperative plant (F) engaged in product manufacture as a major source of revenue rather than as an essential subsidiary operation. Sales included butter, khoa, casein, curd (yogurt), and ice cream.

Distribution systems. Small, unrefrigerated, milk-distribution booths were the basic element in the distribution system of the public dairies. Customers were served only at booths placed in low and high income neighborhoods, providing less convenience than the cycle-dudhia. The use of milk booths had been abandoned by plant E and milk was being delivered by cycle riders.

Milk-distribution booths were attended by part-time public employees. These employees generally were salaried; however, plant B had begun paying on a commission basis.

Bottled and bulk can milk was delivered to booths twice a day. Precise information on the proportion of bulk sales was not generally available. With the exception of plant B, where low-fat milk sales were encouraged in low income neighborhoods, management was attempting to eliminate bulk sales.

Public dairies were using a quota system to allocate milk supplies to consumers, who were required to present an identity card at the neighborhood booth and to pay in cash. The number of card holders was based on plant output in the short season. Although quotas were increased in the flush season, some of the plants had large milk returns.

The number of milk booths in use varied with size of plant and date of initial operations. Plant A operated 800 booths. The volume of sales per milk booth at Plants B and C was over 400 liters. Plant A had about half that volume and plant B less than one-quarter (table 31).

Plant F, the cooperative, did not employ a booth distribution system. Bulk can milk was delivered door to door by cycle vendors. This plant also was engaged in selling hot milk at "milk bars" located in the bazaar areas. These sales were in direct competition with traditional halwais.

Marketing costs

Marketing cost per liter of sales were computed by plants A and E, and

Table 31. **Number of milk distribution booths and fluid-milk sales volumes of case-study plants, 1965-66**

Item	Plant designation			
	A	B	C	D
Number of booths	800	109	22	43
Daily fluid-milk sales (liters)	161,786	45,099	9,871	3,832
Daily sales per booth (liters)	202	414	448	89

Source: Plant surveys.

costs for plant B are as budgeted by the researcher from plant records (table 32). A linear projection of costs at plant B indicates that at full capacity the cost per liter would be 16 naya paisa, a decrease of 5.5 np. It is doubtful that plant A could reduce unit cost of marketing to less than 12 or 13 np. through greater use of capacity.

Differences in the degree of integration of functions and in plant use make investigation of scale economies difficult. Details of cost attributed to various phases of the marketing operation were available for plants B and C only, which are of similar capacity. Scale economies are adversely affected by high procurement and distribution costs.

Plants of 300 thousand liter capacity are rare in India and may continue to be. Plants planned for installation during the Fourth Plan period (1966–67 — 1967–71) are 6,000 to 10,000 liter capacity. These plants should be run at lower unit cost than plant E; but, with continuance of present general-management and investment policies, costs at plants of this size are not likely to be less than 25 or 30 naya paisa per liter.

Financial records maintained by plant B provided a basis for detailed breakdown of marketing costs (table 33). The components of cost at this plant differ substantially from those of American dairy plants. Wages, salaries, and selling commissions account for 41 percent of marketing costs; these expenditures constitute 52 percent of the marketing bill in American

Table 32. **Cost of market service provided by the modern system, by major functions, India†**

Activity	Plant		
	A‡	B†	E*
Period	1963–64	1964–65	Jan. 1967
	Naya paisa per liter§		
Milk procurement	4.4	.9	4.2
Transportation	—	—	11.2
Processing	6.4	10.9	15.7
Management	—	—	3.2
Distribution	4.0	9.7	7.4
Other	1.2	—	.8
Total	14.9	21.5	42.6

Source: Plant surveys.

* Computed from monthly report to state cooperative department

† Cost of powdered milk excluded.

‡ Management and transport allocated.

§ 100 naya paisa to the rupee.

Table 33. **Components of marketing cost in case plant B, 1964–65***

Expenditure	Naya paisa per sales liter	Percent
Capital overhead:		
equipment	2.86	13.7
buildings	.88	4.2
Wages and salaries	6.36	30.5
Selling commissions	2.08	10.0
Bottles	.83	3.9
Aluminum foil	.72	3.5
Coal	.43	2.1
Electricity	.61	2.9
Maintenance:		
plant	.42	2.0
vehicles	1.69	8.1
other	.59	2.8
Advertising	.72	3.4
Other expenses	2.66	12.8
Total	20.85	100.0

Source: Plant surveys.
* Interest on public debt excluded.

plants (36, p. 2).[9] Labor and management costs in plant B appear high, considering relative wage rates.

Maintenance, rent, and depreciation constitute 31 percent of costs at plant B versus 14 percent of cost at American plants. Containers contribute 7 percent at plant B versus 15 percent at American plants. Sixty-two percent of sales in American plants are in paper containers, 33 percent in glass, and 5 percent in bulk dispensers. The advertising proportion of cost is similar, reflecting the response of management in plant B to the need for public education on new product lines.

Utilization of plant facilities

Contribution of physical capital to the cost of marketing is a direct function of plant utilization. A high proportion of total investment is in processing, filling, and distribution facilities. All fluid-milk products are passed through the pasteurizing unit and either the bottling line or bulk can filling units.

Plant capacities are based on ratings by dairy engineers in this analysis of plant utilization. The rating assumes a single shift operation of pasteurizing and bottling equipment and twice-a-day milk receipt and dispatch. It is

[9] U.S. cost data are 1964 averages for 70 fluid-milk distributors subscribing to a cost-comparison service by the USDA. Very small firms, very large firms, national chains, and producer–distributors are not included.

Table 34. **Utilization of processing capacity in case-study plants, India, 1965–66**

	Plant					
	A	B	C	D	E	F†
Daily capacity (thousand liters) ...	300	60	60	10	6	10
First year of operation .	1960	1962	1965	1962	1964	1962
Average daily procurement (thousand liters):						
High month	173.0	32.4	14.3	5.3	3.7	
Low month	85.0	19.8	3.8	2.3	2.5	
Annual	141.0	36.3*	7.7	3.2	3.2	11.2
Percent of capacity:						
High month	57.7	54.0	23.8	53.0	61.7	
Low month	28.3	33.0	6.3	23.0	41.7	
Annual	47.0	60.3*	12.8	32.0	53.3	112.0
Average daily sales‡ (thousand liters):						
Annual	162.0	45.1	9.9	3.8	2.3	10.8
Percent of capacity ..	54.0	73.8	16.3	38.0	38.0	108.0

Source: Plant surveys.

* Dairy B substantially increased through-put in 1965–66 by the purchase of bulk pasteurized milk from a nearby cooperatively owned milk products plant. The average daily purchase was 11.2 thousand liters.

† The June low in plant F is 25 percent of the December high. Plant F has an extensive products enterprise.

‡ Includes reconstituted skimmed milk powder.

likely that these rated capacities understate the real potential of fluid-milk processing plants. Although the perishability of milk in both procurement and distribution channels causes inflexibility in the scheduling of plant operations, management of the fluid-milk plant located in Chandigarh had successfully introduced a double-shift operation. Consequently the plant was operating at twice its rated capacity.

Based on the volume of liquid-milk sales, plant F achieves the highest percent of capacity (table 34). The bottling unit at this plant was inoperative, but it is apparent that this did not hamper sales.

Plants C, D, and E were operated substantially under capacity. The reason stated for this at plant D was location in an inferior dairy tract, and at plants C and E, competition from traditional marketers. Plant C (operational in 1965) was selected to expose the researcher to problems faced by modern dairies in the early stages of activity. Lack of experience in procurement operations and the need for producers to adjust to the new market outlet held plant utilization to 16.3 percent.

Plant output is the best measure of equipment use, and also is an indication of the number of consumers served in relation to the planned po-

tential. If only the volume of whole milk procured is considered, this is a measure of the extent and efficiency with which various plants provide marketing services to milk-producing households (table 34).

The relatively high level of whole milk purchases by plant B was not entirely due to the expansion of village procurement by the dairy. Pasteurized milk, standardized to 3.5 percent butterfat, was transported by road tanker from a cooperatively owned milk-products plant, which served plant B as a seasonal balancing facility. Cooperative efforts of the two enterprises resulted in high capacity.

Procurement and pricing of milk supply

Seasonality in procurement. During a 7-year period of milk procurement at case plant A, the degree of seasonality had increased rather than diminished. During 1965–66, the June low in milk procurement was at the 1960–66 average level, while the March peak was more than 25 percent greater than the 1960–66 average. In 1965–66, March procurement exceeded June by over 100 percent.

Increases in the volume of milk procurement by plant A had not been the result of greater production, but of geographic expansion of the milkshed. This increased the number of milk-supplying households with 1 or 2 animals and the seasonality of supply.

Procurement of both cow and buffalo milk by plant B increased in summer and again during the winter months. At plants D and E, where buffalo milk predominated, seasonality was slight. At plant C in southern India, cow milk procurement peaked in December–January and minimum procurement occurred in August.

Rising prices of traditional milk products and competing procurement by modern dairy product plants contributed to seasonality of procurement in case-study plants. Milk producers may have utilized the public sector plant procurement system as an outlet for seasonal surpluses. At the Hindustan Level milk products plant at Etah, seasonality of milk procurement followed the same pattern at fluid-milk plants in the region and peak procurement was 10 times the quantity purchased during the short season. This suggests that in the short season milk supplies are lost to the traditional milk products manufacturer or to household use. The seasonality may be caused by shifts in household milk selling activity or by movement of dairy cattle.

Calving patterns and lactation curves discussed in chapter 2, (figures 1 and 2), cause fluctuations in milk production. Fluctuations in milk supply will continue where rural households selling to modern milk plants carry on milk production as a subsidiary or even a subsistence enterprise. The trend in milk production in Mehrauli block suggests that adjustments will take place under favorable marketing circumstances. Idle plant capacity, a result of seasonality of procurement, will continue to be a major factor contributing to high marketing costs in the modern system.

Pricing of milk purchases. Generally, both milk buying prices and selling prices were set by local or regional price committees, not plant management. Representative of various departments of government, producer cooperatives, and private milk suppliers generally serve on these committees. While local and regional government members tend to represent urban interests, producer interests are well represented in those communities having strong producer cooperatives.

Inquiries on pricing at the case-study plants revealed some exceptions to the general practice. Plant A contracted with private individuals engaged in milk collection among villages near chilling centers, as a source of supply. Plant B was supplied by a number of district unions of village producer cooperatives. Dairy industry leaders arbitrated differences in producer interests since the price committee was unable to achieve accord.

At the cooperatively owned and operated plant F milk purchase prices were set by management on the basis of expected returns from operations. Surplus over operating costs was periodically refunded to members.

Seasonal price adjustments in effect at plant A since 1961–62 resulted in higher June prices and lower October through April prices (table 35). The adjustment amounted to .21 rupees per liter. Other case-study plants did not engage in seasonal pricing.

Various means were employed for adjusting purchase price to qualitative differences. Plants A, B, and C adjusted the milk price on the basis of fat content and set limits on the acceptable solids-not-fat (SNF), content. Plant B paid for cow's milk on the basis of total solids content. The smaller public plants, D and E, paid flat rates for cow's and buffalo's milk which met certain standards of fat content.

Table 35. **Trend in the purchase price of buffalo milk in case-study milk plants, 1961–66**

Year	A*			B*	F†
	June	Dec.	Avg.	Annual	Annual
	rupees per kilogram				
1961–62	.562	.402	.457	—	—
1962–63	.589	.402	.467	.599	.583
1963–64	.590	.430	.483	.590	.610
1964–65	.640	.615	.616	.625	.651
1965–66	.804	.590	.665	.728	.675
Percent change 1962–66	—	—	42	22	16

Source: Plant surveys.

* 6.5 percent fat, 9 percent solids-not-fat (SNF).

† Value per kg. of total cow and buffalo purchases.

The purchase price of milk in public-sector plants was strongly influenced by commitment to low urban consumer prices. Financial difficulties which stemmed in part from low selling prices tended to influence purchase prices, more than considerations of supply response. In effect, the public plants have attempted to subsidize urban milk consumption and capitalize dairy industry modernization through price effected income redistribution. It had been assumed that, in the absence of a fluid-milk marketing channel, rural milk had little value and could be procured for a low price. Such price policies are effective when employed to aid industrial growth through income transfers from the agricultural sector (19). These price policies are not effective within a regionally confined industry unless arbitrary restrictions are placed on marketing activity.

Historical data on milk purchases were available only for plants A, B, and F (table 35). Of the plants procuring milk in 1962–63, plant A, the largest, was paying the lowest price. Price increases had been significant at this plant during 1962–66 and were currently similar to those paid by the smaller plants.

Locational aspects of milk procurement. In case-study plants, milk supplies were purchased from villages at least 10 or 12 miles from the urban center. The "milkshed" of the modern fluid-milk plant was generally bounded on the urban side by the procurement area of the traditional milk trader; in rural areas plants were increasingly in competition with modern milk-products manufacturing plants.

Plant A initially operated milk-chilling centers within 10 miles of the urban plant, but these were not successful and had to be abandoned. The public plant did not offer producer prices that would draw milk away from the traditional milk traders operating in the area. The 15 naya paisa per liter marketing cost in plant A (table 32) made it difficult to compete with the traditional milk seller having less than half these costs (table 20). By offering the service of household delivery the dudhia may increase this advantage in communities where unbottled milk is preferred.

Selection of product lines made the cooperative plant F successful in procuring nearby milk. Dairy products such as khoa, butter, and ice cream were produced to meet the increasing demand of higher income urban residents for non-fluid dairy products.

Modern fluid-milk plants reach beyond both the supply areas of urban based traditional fluid-milk marketers and dairy-products manufacturers (with the exception of the ghee market). Modern milk products manufacturers have located their plants in smaller urban centers and towns in which urbanization has not yet been extensive, but where superior resources exist for milk production. Thus, milk collection costs are less than for fluid processing plants. In India, this advantage is enhanced by high returns to product manufacture and the efforts of public-sector fluid-milk plants to keep purchase prices at low levels.

Management of case-study and other plants suggest emerging conflicts of

interest between private product plants and public fluid-milk plants such as the Delhi Milk Scheme (34, 7). Management of these plants had been strongly supporting a program to set arbitrary government enforced limits on the area within which product plants are permitted to procure milk (17).

Selection and pricing of liquid and manufactured product lines

Policy makers in the public sector have attempted to specialize in consumer service to low income groups. Price levels have not been low enough to permit purchases by the lowest income groups, and traditional milk vendors compete in many communities. Traditional and modern dairy products were directly competing in consumer markets, with the exception of processed cheese, recently introduced by modern plants.

Although food prices in general and milk prices in particular have been rising rapidly since 1960, fluid-milk prices at plant A did not change between 1960 and 1964. Retail milk prices of over Re 1.00 were still 40 to 55 percent greater than public-administered prices. Selling prices in plant B were constant during 1961–65, with slight increases during 1961–66 (table 36).

Buffalo-milk prices reported by the CSO for 1966 were substantially higher than those charged by most public plants (table 37). Considerable intercity differences existed in the level of bazaar prices for buffalo milk and ghee. In the cities of Delhi and Ahmedabad, fluid-milk prices were considerably lower than other urban centers. The buffalo milch animals in these areas were superior and access to the city by traditional milk marketers was good. Buffalo-milk prices in Calcutta and Bombay were 62 and 67 percent greater, respectively, than in Delhi. In Bombay, access by traditional milk marketers was limited by law and by physical terrain. Congestion in Calcutta was a major factor in increasing milk cost. Milch buffaloes in that region were not as high milk producers as those in western India.

Employment and labor productivity

As processing and transport facilities are designed to be labor-saving, the level of employment in dairies is a measure of efficiency of use of invested capital (table 38). Employment by the dairies was much higher than in comparable western processing and marketing establishments. This is a consequence of the integration of marketing functions and due in part to overstaffing by public-sector plants. Increments in levels of employment are commonly reported as achievements of a dairy. Although management of case-study plants would not affirm it, casual observation suggested that employment levels in plants were influenced by the responsible government agencies.

Comparative labor efficiency among modern plants was determined by

Table 36. **Product line and prices at case-study fluid-milk plants, 1965–66**

Plant	A	B	C§	D	E	F
Milk:			rupees per liter			
Buffalo (bulk)	.70	.80	†	1.10	*	1.00
Buffalo (bottled)	.70	.84	†	1.10	†	†
Cow (bulk)	.70	*	.94	†	†	.92
Cow (bottled)	.70	.70	‡	†	†	†
Toned (bulk)	.44	.60	†	.88	†	†
Toned (bottled)	.44	.64	†	.88	†	†
Double-toned (bulk)	*	.50	.62	†	†	†
Double-toned (bottled)	*	†	‡	†	†	†
Standardized (bulk)	†	.80	†	†	†	†
Standardized (bottled)	†	.84	†	†	†	†
Sterilized (coffee)	1.40	†	†	†	†	†
Sterilized (chocolate)	1.60	†	†	†	†	†
Skim	†	.25	.19	†	†	†
Products:						
Cream	*	4.00	6.00	*	5.00	4.72
Butter	*	8.00	7.00	*	*	5.88
Ghee	*	9.50	9.00	†	†	*
Casein	*	†	4.20	†	†	2.42
Khoa	†	†	†	†	†	7.46
Whole milk curd	†	†	†	†	†	.92
Skim milk curd	†	†	†	†	†	.27
Cooking butter	†	†	†	†	†	5.95
Buttermilk	†	†	†	†	†	.23
Ice cream	*	†	†	†	†	†

Source: Plant surveys.
* Price data lacking.
† Not in product line.
‡ Limited quantities.
§ Plant receives mixed buffalo and cow's milk testing 3.5–3.8 butterfat.

computing the volume of procurement, volume of sales, and capital investment per man day of labor force (table 38).

Milk sales per man day show the relative efficiency in the achievement of consumer services objectives. At plants A, B, and C performance was increased by the use of reconstituted skim milk powder. At plant F fluid-milk distribution per man day was relatively high, even though product manufacture was substantial. Product manufacture was forced at plant E by failure to effectively implement a fluid-milk distribution system, reducing milk distribution per man day.

The volume of milk procured per man day indicates the performance of plants in relation to producer services provided. Plant B achieved a significant advantage over other plants by transferring procurement functions to the supplying cooperatives and making heavy use of skim milk powder. This is reflected, however, in milk purchase prices (table 35). The staff and capital equipment employed in procurement by plants A and C contributed

Table 37. **Average annual buffalo milk and ghee prices in selected Indian cities, 1966**

City	Buffalo milk (liters)	Buffalo ghee (kilograms)
	rupees	
Bombay	1.84	11.80
Calcutta	1.70	10.80
Delhi	1.06	10.60
Madras	1.34	12.24
Ahmedabad	1.07	10.89
Bangalore	1.21	11.40
Hyderabad	1.30	9.03
Kanpur	1.24	9.96

Source: Computed from price data published in the Monthly Abstract of Statistics, CSO, India.

significantly to costs. Efficiency in procurement at plant F was increased by the purchase of urban and nearby milk.

Comparative contribution of capital investment to marketing costs is indicated by the level of investment per man day. The particularly high level of investment at plant C was largely a consequence of idle plant capacity. Although capital investment was high in plant B, efficiency in procurement and distribution indicated comparative success in equipment use. In plants E and F, capital investment per man day is inflated as bottling lines were idle and only small quantities of milk were hand-bottled.

Labor utilization. It was not always possible in all cases to determine employment in plants by job assignments. The labor required to perform all distribution services was reflected in the employment at plant A. Of the 2,394 man days of employment, 812 were at distribution booths. Plants B and C employ 217 and 212 personnel, respectively, at the main dairy plant (table 39). Plant C employed more than 3 times as many in procurement as plant B, even though milk purchases were one-fifth of those at the latter plant. On the other hand, plant B employed nearly 8 times as many personnel in milk distribution. The large number of procurement personnel at plant C resulted from the recent establishment of the plant and its location. Relatively few distribution personnel were employed at plant C, as milk sales were limited and mostly in bulk cans. Employment at plant C was expanded by the retention of a staff of dairy engineers employed to oversee initial operations. Additional labor was required to maintain gardens planted around the dairy.

Specific examples illustrate how labor was used in the plants. The crew of procurement and distribution vehicles generally was 3 or 4. The accounting section of a 60,000 liter plant had any as 30 personnel. Government departments delegating the power to d. es to employ personnel sanctioned the employment of up to 40 unskilled laborers at dairy plants of this size.

Table 38. **Volume of milk handled per man day of employment in case-study plants, India, 1965–66***

	A	B	C	E	F
Total daily employment	3,205	461	290	159	140
Equivalent man days	2,394	346	275	159	140
Volume handled per man day — liters:					
Whole milk procured ..	59	105	28	20	80
Fluid milk distributed ...	68	128	36	14	77
Capital investment per equivalent man day — rupees	11,984	20,803	37,644	5,176	9,286

Source: Plant surveys

* Employment data on plant D are inadequate.

American dairy economists specify 23 men as the man power requirement of a 50,000 quart per day plant (37, p. 20).

Financial results of modern plant operations

Although the 5 public-sector plants were intended to operate on a break-even basis, losses at most plants were substantial. The losses were absorbed by the operating governmental authority. While plant B has been making progress in the reduction of losses, plant A experienced a serious setback in 1963–64. Wage payment and the cost of milk procured rose significantly, while retail prices were maintained at low levels (table 40).

Table 39. **Job assignments of employees in case plants B and C, 1965–66**

Position	Employees per plant	
	B	C
Garage (vehicle maintenance)	15	31
Cooperative	—	14
Main dairy (operation and maintenance) ...	84	115
Distribution	60	12
Procurement	13	46
Administrative (clerical)	48	37
Milk booths and commission sellers	231	32
Laboratory	10	3
Total	461	290

Source: Plant surveys.

Table 40. **Financial losses incurred in case-study, modern dairy plant operations, India, 1961-66**

	A	B	C	F
	thousand rupees			
1961-62	636	1,154	—	*
1962-63	595	757	—	*
1963-64	2,309	122	—	*
1964-65	*	186	—	*
1965-66	*	*	1,240	−30†

Source: Plant surveys.
* Results not available.
† Approximate profit.

Chapter 5.

Potential for Improving Market Performance

Comparative Effectiveness of the Modern Fluid-Milk Systems and the Cycle-Dudhia System in the Context of Primary Problem Areas

Provision of consumer services

Certainty of milk quality

The usefulness of consumer services provided by the modern fluid-milk plants is a highly controversial subject. Integrity of both the traditional milk marketers and persons in the employment of modern plants is involved. Milk has a high value relative to the general wage level. It is easy for those handling milk to pilfer the product through the substitution of water, with consequent dangers to health.

The practice of boiling milk has not reduced the concern over potential "adulteration". It is routinely cited as a prime reason for modernization and, within the modern system, as justification for consumer packaging.

The usefulness of pasteurization to the Indian consumer cannot be compared with the utility of the process in western countries. Home refrigeration, coupled with pasteurization, has made it possible for the U.S. consumer to purchase milk only 2 or 3 times weekly. The twice a day delivery required in Indian markets cancels this advantage of pasteurization. Western consumers were accustomed to drinking cooled unboiled milk at the time of the introduction of health legislation requiring milk to be heat treated. The purpose of high temperature pasteurization was to achieve a safe prod-

uct without changing the natural flavor. The Indian consumer prefers the caramelized flavor of boiled milk and therefore boils the pasteurized product.

Standardized quality is a substantial benefit provided by modern plants. Milk with a variety of fat contents was clearly identified (through color coding of foil caps). The SNF content of all milks was maintained between 8.5 and 9 percent. Much of the milk distributed by the modern system had a lower fat content than was commonly available in traditional markets but may have been higher in non-fat solids. The consumer purchasing this low-fat milk is assured that the alteration is achieved by skimming and not by dilution.

The benefits gained from the introduction of bottled milk are mixed. Bottling reduces the probability of milk alteration outside the plant, but also increases the probability of theft. The bottles are easily concealed and worth half the price of their contents. Management of several dairy plants indicated that loss of milk through pilferage was a problem. Dairy A had 3 persons assigned to each of its distribution booths. One of these was a *chowkidar* (watchman). Continued efforts should be made to design a secure system of bulk can distribution since the bottling plant requires a substantial investment.

It is not sufficient to simply design a bulk can from which the cover cannot be removed without detection. Dilution can be achieved by submerging a standard milk can in a tank of water. The can must either be securely sealed, or it must be designed to prevent complete emptying. If the container cannot be emptied, tests may be conducted on the residual milk to ascertain if the product has been altered. Experimentation would determine whether butterfat or SNF tests would be required to detect dilution. A bulk can equipped with a securable lid and a bottom tap is one possibility. The tap could be designed to prevent complete emptying of the sealed can.

The possibility of dispensing with bottling lines and distributing milk in bulk should be considered for the 6,000 to 10,000 liter plants now being planned for smaller urban communities. Costs may be higher for these smaller plants and the traditional systems may be even more competitive than in the larger urban communities.

Success in developing secure distribution containers could have a significant effect on the retail distribution system. Public-sector use of the booth distribution system is due partly to mistrust of the retail food trade. With the threat of dilution eliminated, bazaar shops might engage in distribution on a commission basis. A daily visit to the bazaar is part of the routine of the Indian household. Booth distribution accounts for about one-third of the total operating costs at larger plants (table 32). Staffing of the booths accounts for the highest portion of this cost.

Suitability of product lines

Efforts to achieve economical packaging and distribution systems are useless if the basic product is not suited to the consumer's need. The type of

milk and marketing services provided by the traditional system should be studied before a modernization program is initiated. If a new system provides milk with a substantially different fat content than residents are accustomed to, the product may not be readily accepted. Innovations that add to consumer satisfaction should be considered, but should be introduced on an experimental basis with selected groups to determine cost and value to consumers.

Modern public milk plants have attempted to create a market for particular types of milk product rather than to search for existing needs of the market. Stimulating demand for basically new forms of food service is a formidable task in India. The importation of a service is an effective means of accelerating technological development but invariably entails the risk of failing to generate demand in a different environment.

The use of imported technology by public-sector fluid-milk plants is especially hazardous since these plants are attempting to serve low income groups. Modern milk products plants (which cater to middle and higher income groups) have found it necessary to develop products particularly suited to the Indian market. While it is not the objective of this study to examine the modern milk products sector of the Indian dairy economy, it is essential to note the success achieved by these firms.

The Kiara District Cooperative Milk Producers Union at Anand is an example of success in the cooperative sector and is widely cited by both economists and sociologists. Commentary will be confined to a few aspects of operations as they pertain to service policy in fluid-milk plant operations. The Kiara cooperative is operated by a confederation of over 500 milk producer cooperatives having in excess of 85,000 members (3). Product lines have been developed to insure market outlets for the milk supplied by the membership. Accumulated capital has been used to develop veterinary and other services for cooperative members. The cooperative has utilized the expanding urban demand for dairy products to establish a flow of income to support further development.

The leaders of the cooperative have successfully resolved the issue of conflicts in social objectives which rise out of the acquisition of physical capital through governmental channels. This has been achieved through contractual arrangements to make specified deliveries of bulk pasteurized milk to urban fluid-milk distribution plants. The cooperative has introduced baby food and processed cheese, products which are not handled by the traditional milk marketing system. Simultaneously, they have supported programs for governmentally administered systems of grading traditional ghee and creamery butter and establishment of a distinct identity for these products.

Potential for qualitative improvement in traditional markets

The high cost of achieving qualitative improvement through capital intensive market technology impels consideration of the potential for qualitative improvement within traditional markets. The consumer may be capable of

at least partially correcting the economic loss from dilution by demanding price adjustments, but there remains the possible hazard to health from water borne disease.

The most serious disease caused by the milk itself is undulant fever. Danger from this disease is eliminated by bringing the milk to a boil. Water is more dangerous to health because it may carry organisms which are destroyed only by prolonged boiling or by high temperature treatment.

Laws against milk dilution are costly to enforce in traditional markets. Alternatively, unpasteurized milk sales could be banned entirely and all milk destined for urban consumption required to be processed through modern plants. These marketing services are costly, reducing consumption by lower income groups.

The generally greater profit realized from separation and cream sales might be the basis for an alternative approach to qualitative improvement. It would seem advisable to insure that "dairies" performing this operation maintain reasonable levels of sanitation and that dudhias using such facilities achieve some degree of uniformity in milk sales. The practice of using the services of "dairies" to adjust fat content (and price) to suit the needs of different customers should be encouraged. A reasonable enforcement of standards should enlist the cooperation of "dairies" and dudhias. The manner in which such a program is approached could be critical to its success. A low-keyed program to establish and promote quality standards would have the effect of easing public distrust in the dudhia and the dudhia's distrust in the public official.

The municipal authority who has the responsibility for enforcing food adulteration laws may view any suggestion of voluntary participation by milk sellers as naïve. In the absence of a competing modern dairy system this might be a justifiable stand. As modern dairies increase their penetration of the market, incentive will increase for traditional marketers to take more interest in either collective or governmentally sponsored steps to improve their product and the public image of their product.

A grades or standards program would enhance rather than retard the service the traditional marketer offers the consumer. To implement such a program, concern with urban consumer health must be tempered with similar concern for efficient use of resources for milk production and the accompanying real income benefits to both the rural and urban populations.

Public welfare aspects of urban milk production

The urban stable poses a set of problems different from those caused by other traditional milk marketers. The issue of "cattle nuisance" represents one problem. The stables influence the esthetics of communities and may create health problems. Municipal governments have failed to take action against urban stables and have aided the growth of such enterprises by making public lands available at minimal cost. Municipal authorities appear to respond to an expressed desire on the part of residential communities for the

presence of urban stables, not to the more general matter of cattle nuisance.

The cattle-nuisance argument is one of public welfare. Prohibitive statutory measures will be based on what community leaders perceive to be acceptable to the public and in their best interest. One of the basic reasons for the prevalence of the urban system is that it offers the consumer some assurance against dilution.

The previously outlined course of attempting to upgrade the quality of milk marketed by nearby rural areas could provide an alternative solution of consumer attachment to urban-produced milk.

Servicing of rural milk-producing households

The major result of the modernization program in rural areas is the increased number of communities with access to urban fluid-milk markets. However, additional communities will not be served if fluid-milk prices are so low that rural households continue products manufacture. The modern fluid-milk plants in general did not offer producers serving the traditional fluid-milk market an alternative outlet, as prices were not competitive.

Villages located more than 10 to 15 miles from the urban center have benefited from market modernization. Rural milk-chilling centers and transport by motor vehicle have permitted rural households located as far as 60 miles from urban centers to market fluid-milk. Formerly these households were able to market only milk fat.

Low milk yields and small stable sizes in rural areas result in high cost of assembly. Vehicles make numerous stops for small quantities of milk. One-and-one-half-ton trucks are commonly employed to permit rapid transport over poor roads. These vehicles carry a small fraction of their designed load.

Prospects are poor for reducing the cost of milk collection from distant villages. Costs can be reduced somewhat by employing labor intensive methods of transportation to reduce the number of pickup points on procurement routes. This was a frequent practice at case-study plants.

Dairy animal husbandry practices in Mehrauli suggest considerable scope for reducing milk assembly costs through increased production. If public dairies reduce efforts to serve all villages in broad regions and concentrate on those with greatest potential, improved livestock management practices may develop as they have in traditional markets.

The cycle-dudhia system in Mehrauli has permitted households to benefit substantially from rising demand for milk in the Delhi market. The volume of milk marketed from the area has expanded rapidly. Milk production in the area increases utilization of crop by-products and family labor and provides a more even cash flow than crop production. Regulations designed to improve the qualitative performance of the traditional systems should not be imposed unless alternative and equivalent market services are provided to nearby villages.

Stimulation of increased milk production

The dairy plant as a vehicle for innovation. Increased access to market, coupled with adequate producer prices, can result in greater use of available rural resources for milk production. The procurement system of modern milk plants also may be used to bring new production methods and technology to the village community. The presence of a market outlet changes attitudes toward milk selling, an activity frowned upon in some parts of rural India. Income benefits from sales to the modern plants should make distant villagers receptive to new concepts. Modern plants can aid production through the provision of veterinary services, livestock feeds, and credit facilities for livestock purchase.

Reduction in the seasonality of marketings

Irregular supply causes fluctuations in retail price levels and milk consumption and the number of purchasing consumers.

In traditional markets the fluctuations in fluid supply are partially dampened by 3 different processes. Seasonal changes in the quantity of fat removed from fluid-milk, variations in milk dilution, and movement of fresh animals into primary selling areas permit some restraint in price adjustment by milk sellers. Seasonal price fluctuations in the Mehrauli market, nevertheless, were substantial.

Divergent calving cycles for cattle and buffalo indicate the possibility of decreasing seasonal variations in milk receipts through the provision of price incentives to either cow or buffalo milk sellers. In regions having substantial numbers of cows, purchase of cow's milk may compensate somewhat for the spring and summer decline in buffalo milk receipts. Numerous sources of data on buffalo milk production indicate a need for research on breeding patterns.

Public milk plants procure milk over extensive areas, paying low prices to households possessing few milch animals. Collection of milk is seasonal. Under such circumstances it is unlikely that producing households are able to engage in livestock trading to maintain milk production for sale throughout the year. Such activity would be possible on the perimeter of the procurement area, if price incentives were adequate.

Only one case-study plant (A) engaged in seasonal pricing of milk. Summer purchase prices for buffalo milk were increased by 35 percent over December prices from 1961 through 1966 (table 35). This pricing policy had not reduced the seasonality of milk receipts. Usage of skimmed milk powder by processing plants was increased in the summer months, compensating for reduced whole milk procurement.

Use of international milk-powder donations

Introduction. Skimmed milk powder is an agricultural commodity fre-

quently in surplus supply in several western nations. National and international agencies have been successful in acquiring locally surplus milk powder at concessional prices for distribution in low income countries. Aiding agencies generally intend that donations of milk powder be distributed to those communities within the recipient nation in need of the milk nutrients. Insuring that low income groups actually consume the milk powder is difficult since the commodity is storable and has a high market value. Powdered milk is not familiar to rural or urban low income groups who appreciate its exchange value more than its nutritional quality.

Skimmed milk powder is commonly reconstituted prior to distribution to insure that it is consumed and not marketed. Public sector plant distribution of toned milk is the principal means by which this is accomplished in India. Some of the donated powder, as from CARE, is distributed free to certain groups such as school children or expectant mothers. CARE compensates the plant for processing services.

Traditional milk markets can be of no assistance in the distribution of donated milk powder. Temptation to divert the product to the most lucrative market would be substantial; effective policing of the flow of the commodity through market channels would not be possible.

Integrated distribution systems. Modern public sector fluid processing plants offer certain advantages for powder utilization. Buffalo milk surpluses permit the addition of fat to the reconstituted product, improving its acceptability. Milk distributed to schools is consumed as purchased, necessitating pasteurization for health protection. Although the lowest income groups do not consume significant quantities of toned milk sold through modern plant distribution systems, the capacity of the system to serve a broad spectrum of the community is increased with the use of skimmed milk powder.

Specialized milk powder distribution facility. Imported skimmed milk powder has been channeled through fluid milk plants designed primarily to handle domestically produced milk. Specialized distribution systems could be established to handle donated or concessional powder imports. Such a facility has been established in Mexico City to serve low income groups not served by the domestic dairy industry (18, p. 30). Information is not available on the extent of public subsidization. The processing plant is operated by a government agency (Compania Nacional de Subsistencias Populares). This plant uses a combination of imported skimmed milk powder and locally produced vegetable fats to produce a product acceptable to consumers.

Specialized distribution facilities in Indian markets would have both advantages and disadvantages compared to current practices. The major advantage is that it can be designed for a specific purpose. It can offer minimum service, thereby reducing the level of capital investment required. Bulk distribution would be possible in Indian markets. Nutritional improvement and low consumer prices could be emphasized in choosing product lines. This could confine subsidized milk consumption to lower income groups.

Success of specialized distribution is dependent upon a stable supply of

imported powder. Longer term commitments by developed nations to provide quantities of powder on specific terms is an essential prerequisite to success of this program.

Current dependence of public sector fluid-milk plants on imported milk powder is a serious impediment to specialization in Indian markets. Abrupt transfer of imported powder distribution to specialized facilities would seriously disrupt the current modernization program by reducing plant volumes and increasing seasonality of distribution.

Modern milk plants make effective use of high fat buffalo's milk in producing the lower price "toned" milks. Research on the manufacture of butter oil and recombining of this oil with reconstituted skimmed milk powder is essential for effective operation of a specialized system. Such research also would contribute to the solution of seasonal fluctuations in the operation of the present system.

Measures of comparative productivity

Marketing costs

When the objective of investment in marketing facilities is to insure the availability of quality milk to all income groups, the cost of marketing services is of critical importance. If the modern systems are to replace the traditional, the cost of improved service must not greatly exceed those prevailing in traditional markets.

The largest case-study plant (A) incurred the least cost per liter (15 np.). This was 50 percent greater than the marketing costs incurred by medium sized cycle-dudhias (10.4 np.). The larger cycle-dudhias achieved marketing costs that were less than half of those at the lowest cost modern plant. Cost at the smaller plant (E) was 4 times that for medium sized dudhias and 6 times that for larger dudhias (table 41).

Table 41. **Comparative cost of marketing in modern and traditional marketing systems, India**

Item	Size category		
	A	B	E
Modern plants			
Capacity (thousand liters)	300	60	6
Daily sales volume (thousand liters)	161.8	45.1	2.3
Cost per liter, (np.)	14.9	21.5	42.6
	large	medium	small
Mehrauli cycle-dudhia			
Daily sales volume (liters)	165	64	27
Cost per liter (np.)	6.7	10.4	17.6

Source: Tables 21, 22, 31 and 32.

Labor productivity

Factors contributing to the cost of marketing services are discussed in detail in Chapters 3 and 4. The principal operational factors contributing to high cost in the modern plants were under-utilization of capital equipment and size of the labor force. The quantity of milk being handled per man day at each of the case-study plants was very low, given the amount of capital investment per man (table 42). Just how low is apparent when the volume of milk handled by the modern and the traditional systems is compared. The volume of milk distributed per man day at plant B was over twice that of larger dudhias of Mehrauli block, but with 85 times the amount of capital. The volume of distribution at plant A was only 50 percent greater than the better dudhias even with 49 times the capital investment. In the absence of skimmed milk powder, productivity in modern plants would be even poorer compared to the dudhia system. This is indicated by comparison on the basis of milk procurement per man day (table 42).

While volume of fluid sales per man day is an appropriate basis for interplant comparisons in the modern system, in making comparisons between the modern and traditional systems this measure has the weakness of excluding from consideration the differences in qualitative performance. Measures of productivity based on the *sales value* of fluid milk are not valid if the product distributed by modern plants is subsidized.

It has been demonstrated that investment in modern fluid-milk processing is increasing labor productivity very little on a volume basis. Services are being rendered by the modern system which are not rendered by the traditional system. In view of the labor productivity in the modern plants, costs of such services appear to be excessive.

Table 42. **Labor productivity in modern and traditional marketing systems, India**

Item	Size categories				
	A	B	C	E	F
Modern plants:					
Capacity (thousand liters)	300	60	60	6	10
Volume of milk procured per man day (liters)	59	105	28	20	80
Volume of fluid milk distributed per man day (liters)	68	128	36	14	77
Investment per man day (rupees)	11,984	20,803	37,644	5,176	9,286
Mehrauli cycle-dudhia:	large		medium	small	
Volume of milk procured per man day (liters)	50		43	23	
Investment per man day (rupees)	244		273	294	

Source: Tables 17, 21, 28, and 38.

Limitations of case studies

The advantage of the case-study approach lies in the scope which it provides for in depth probing of a particular problem situation. The disadvantage of this approach is the possibility that the object of study will represent a peculiar situation and the extent to which research findings can be generalized will be limited. Statistical sampling methods increase the likelihood of producing generalizable research findings; however, the cost of this approach restricts the scope of inquiry.

The Mehrauli survey embodies elements of both the case study and the statistical sample. The market system as a whole represents a case study. The participating village households constitute a sample of the population in Mehrauli block. The marketing operations are probably representative of cycle-dudhia operations in other parts of India because the product is perishable. In some areas other traditional systems such as the rail passenger may be dominant. Production enterprise and milk consumption preferences vary substantially among different regions. The Mehrauli situation is fairly representative of the dairy economy in northern and western India. Particular caution should be exercised in making inferences about traditional marketing activities in eastern and southern India. Mehrauli block has somewhat inferior land and water resources relative to other parts of Delhi territory. Cattle and buffalo breeds in the block are superior dairy animals.

The case-study plants constitute a selected sample of existing modern Indian milk processing and distribution systems. The sample includes plants of various sizes located in different regions of India and both successful and unsuccessful operations. The general approach in selection was to insure variability. However, there may be plants in India which are either more or less efficient than any one of the case-study operations.

Resolution of conflicts in public-sector modernization programs

Effective implementation of the modern marketing system requires some institutional and functional reorganization. Much of the conflict in objectives pursued by public sector plants rises from the numerous objectives which plant management is required to pursue. Organization of the marketing systems must provide management with a clear concept of the objectives of the operation and priorities associated with each.

If the modern plant eventually is to become a self-sufficient economic enterprise, the objective of developing an assured source of milk supply must receive high priority. Procurement and producer price policy must be based on adequate incentives for the expansion of producer marketings. If purchase prices are sustained at low levels, the prospects of success in achieving other goals will be limited.

Persons responsible for the operation of the present system commonly acknowledge that the system does not serve the lower income groups in

India's urban centers. Prices of 40 or 50 np. per liter restrict purchases by laborers earning only 2 or 3 rupees per day. The success of the modern system will depend on providing a standardized, high quality product to a population which habitually consumes milk products. Toned milk permits the consumer to purchase less fat and more protein per unit of undiluted fluid. Purchasers of this product cannot extract fat from the milk for household use and must purchase ghee or vegetable fat to meet these requirements.

Emphasis has been placed on consumer service offered in modern fluid plants. Services are strongly influenced by equipment selection, which is partially determined by national and international aiding agencies. Goals of these agencies may conflict with domestic programs.

Efforts should be made to provide high income consumers with services for which they are willing to pay. Market research should be conducted to determine preferences among middle and high income consumers and products developed to meet these preferences. By actively seeking out and serving higher income groups, the public dairy can improve earnings and thus increase its capacity to carry on some welfare functions.

Welfare distribution of milk should be recognized. Long term plans should be developed to finance these programs. Subsidized milk consumption would place a heavy burden on the domestic economy and efforts should be continued to develop long term supplies of milk powder through international agencies or other channels.

Without foreign assistance the prospect for increasing milk consumption among low income groups is very poor. It is imperative that all possible ways of reducing the cost of the marketing services be explored to keep losses and public subsidies at a minimum.

Public sector plants must be given an independent financial status and management provided with incentive to reduce costs. Current procedures for authorization of expenditures by management are too cumbersome to permit effective management.

Low productivity of labor in public sector plants indicates that current policies of employment are not consistent with low consumer prices. If the modern plants are to achieve success in marketing, current employment policies must be altered.

Serious consideration should be given to the possible substitution of other foods for milk in the program to improve the nutrition of lower income groups. Research is currently under way at the Central Food Technological Research Institute on vegetable protein substitutes (1, p. 22). The institute has introduced a groundnut protein fortified milk in the Bangalore market on an experimental basis. Results of this experiment are not yet available.

Partial modernization in traditional milk markets

The dichotomy of traditional and modern was defined for the purpose of treating the major problems involved in rapid modernization. Consideration

has not been given to the possibility of more gradual modernization with smaller capital inputs. Study of the cycle-dudhia system in Mehrauli indicates potential for modest technical innovation in expanding capacity of traditional systems. The current cycle-dudhia system makes a substantial contribution to rural incomes in areas adjacent to urban centers and displays a flexibility in responding to a wide range of consumer demands.

The cycle-dudhia system is limited in the size of the milkshed which it can serve. The distance which milk can be transported is limited by the speed of the transport and perishability of the product.

Milkshed size can be increased either by swifter transportation on improved roads or by processing milk to retard bacterial growth.

Improving transport

Public conveyance is of limited use to dudhias and cannot effectively serve the transport needs of most operators. Improved transport vehicles can be provided by individual or joint ownership; they must have a low purchase price and a low operating cost. A 2- or 3-wheeled motorized vehicle might offer some potential. At present the demand for motorcycles or motor scooters in India is in excess of supply. Many citizens are in a better financial position to buy such vehicles than the dudhias are.

None of the dudhias interviewed had attempted to use a motorized vehicle. Three of 18 stated that they lacked the means to acquire one. Only 1 of these 3 was using more than 1 bicycle. The other 2 said that they were cycling less than 4 miles and selling to a single buyer; therefore they had no use for a scooter. Six dudhias said they were positive that a motorized vehicle would not be practical.

The reasons given for considering a scooter impractical varied. Two dudhias in zone 3 and 1 in zone 1 felt that road conditions were not suitable. Another, from the village of Mehpalpur said that the scooter is unsuitable because it frequently needs repair, and that, although he might be able to maintain an extra bicycle, he could never afford 2 scooters. He mentioned also problems of cost and poor roads. One of the dudhias with larger businesses stated that when distributing to many customers, it was necessary to have several bicycles in operation simultaneously and that a scooter would replace only 1 bicycle. A similar argument was given against the use of a horse and cart.

Because of the number of households served, the use of powered vehicles is impractical. The average number was 18, but the more successful dudhia operations served 30 households per cycle. These households were in from 1 to 3 different residential colonies — each colony served by a separate cyclist. Although a motorized vehicle could cover greater distances, with larger loads, it could not be used for house-to-house deliveries, because of the cost of fuel and the time required to make so many deliveries. The increased delivery time could cause spoilage.

The trustworthiness of employees was referred to frequently by dudhias as

a major reason for not expanding business by adding another manned cycle. Their expressed fear that the milk would be watered reflects the alertness of urban customers to the amount of water in their milk. The willingness of a few dudhias to employ non-family members suggests that employment would increase if the returns were sufficiently high.

Rough cost comparisons suggest that a scooter would be comparable in cost to bicycle operations for a dudhia using 2 cycles. Scooter transport costs could be further reduced through use of a trailer or a 3-wheeled scooter. Increased loads would require additional employees to make house-to-house deliveries, or else the establishment of neighborhood shops. Some specialization of marketing functions would be necessary and this would not permit a strictly family-run enterprise.

Desire to keep the enterprise within the enlarged family is a common characteristic of most Mehrauli cycle-dudhias. This prevents specialization and restricts the service capability of the system. With greater competition from public sector plants, the dudhias may employ independent distribution agents in urban markets, particularly if low cost motor transport vehicles are available.

Some dudhias of Mehrauli, familiar with cooperative organizations, suggested cooperatives as a means of making use of larger motorized vehicles. But successful operation of such an enterprise would mean loss of individual independence. A cooperative system might be feasible only in areas too distant for cycle transport.

Retarding milk spoilage

If the rate of deterioration of milk in traditional markets can be reduced, flexibility in the choice of transport would be enhanced. In Mehrauli market, no effort was made to cool milk from the supplying villages. The only natural facility for cooling milk was the village well. The cooling time would be excessive with this method. A mechanical cooler would be required to cool milk sufficiently to retard bacterial growth. Materials needed for the construction of simple can coolers are available in India. Villages in Mehrauli are electrified, permitting the use of small electrically powered freon compressors.

No effort was made by the researcher to budget the cost of operating such a cooler. It is likely, however, that coolers could be used effectively only by the largest dudhias, or through cooperative ownership. Smaller villages in most parts of India probably would not market enough milk to permit the use of coolers. Producer cooperatives located in villages 20 or 30 miles from large urban centers might make use of such a facility in conjunction with cooperatively owned transport.

Widening the focus of international aid in dairy development

International aid to dairy development in India falls into two major categories: (1) technical aid in the introduction of processing and transpor-

tation equipment, and (2) donations of skimmed milk powder. This aid has been effective in providing urban markets with high quality, standardized liquid milks. Donations of skimmed milk powder have helped the plants to sustain operations during the initial stages of procurement and have supplemented the domestic sources of milk supply to urban centers. Milk consumption by young people has been increased through school distribution, and the supply of milk to hospitals has improved.

The focus of international aid has been on establishment of modern dairy plants and on alleviation of deficiencies in milk consumption, particularly in large urban centers. Future assistance for dairy development must be more broadly based. Assistance should include facilities and training to conduct systematic research on technical and operational specifications of market systems particularly designed to provide market services to both urban consumers and rural milk-producing households. The type of processing, packaging, and transport presently in use in the largest urban centers will be even less suited to requirements as the size of the communities served declines. The needs of these smaller urban centers should be carefully studied. Domestically available dairy marketing equipment should be carefully assessed as to its suitability. Substantial progress has been made in the dairy-processing-equipment industry in India; if requirements are carefully specified, this industry should be able to provide a substantial part of future requirements. Domestically manufactured equipment should be considered for "rural dairy centers", proposed in the Fourth Plan (12, p. 9). It is suggested that such centers use farm bulk cooling tanks to assist in the assembly and holding of milk until delivery to local small towns or to plants in larger communities. Simple can coolers are available in India and might serve this purpose equally well.

Substantial evidence exists that much larger marketing systems than the proposed rural dairy centers can function effectively without the use of pasteurizing and bottling equipment. The pilot project at Surat in Gujarat State is able to procure and distribute 25 to 35 thousand liters a day, and milk cans are the principal equipment owned by the cooperative. Trucks are hired from surrounding village cooperatives. Villagers rise in the early morning hours, milk the animals, and bring the milk to a central collection point. The milk is picked up, strained, and transported direct to distribution booths in 4 to 6 hours. Surplus fluid milk is sold to traditional milk product producers. In completing the modernization of an operation already as successful as this, Indian planners and international advisors both should thoroughly investigate additional services that may be forthcoming and set strict standards for productivity of the labor and capital required.

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1. Uma J. Lele and John W. Mellor, *Estimates of Change and Causes of Change in Foodgrains Production, India, 1949–50 to 1960–61.* Bul. 2.
2. John W. Mellor and Bruno de Ponteves, *Estimates and Projections of Milk Production and Use of Concentrate Feeds: India, 1951–1976.* Bul. 6.
3. Thomas F. Weaver, *Irrigation Evaluation under Monsoon Rainfall Patterns — A Case Study for Raipur District, Madhya Pradesh, India.* Bul. 10.
4. Ashok K. Dar, *Domestic Terms of Trade and Economic Development of India, 1952–53 to 1964–65.* Bul. 12.

In addition, several studies of Indian rural development have been published in the occasional-paper series of the Cornell University–USAID Prices Research Contract, Department of Agricultural Economics, Cornell University.

Much of the research on India performed in the Department of Agricultural Economics is summarized in a policy context in *Developing Rural India: Plan and Practice,* by John W. Mellor, Thomas F. Weaver, Uma J. Lele, and Sheldon R. Simon (Cornell Univ. Press, Ithaca, New York, 1968).