Chapter 13
Engineering Cattle for Dairy Development in Rural India

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India's Green Revolution[1] has attracted much attention in studies of the social and environmental repercussions of technological innovations. Its consequences for both society and nature have been demonstrated, not only in terms of increased food production, but also in terms of the loss of diversity of crop breeds, inability to maintain the profitability of small and medium land holdings, displacement of agricultural labor, and loss of community-based, and often more sustainable, agricultural practices and forms of knowledge linked to them (Baker & Jewitt, 2007; Roy, 2007; Shiva, 1991). Less highlighted in such studies are changes in animal husbandry that have accompanied the Green Revolution, these being especially pertinent in the context of India given the continuing use of animal power in agricultural operations (Chakravarti, 1985). The upgrading of cattle and buffalo breeds, in fact, has been a central aim of India's dairy development program (Rao, Venkatasubramanian, & De Wit, 1995), whose designation as the "White Revolution" very deliberately evokes comparisons with the Green Revolution (George, 1985).

This chapter focuses on the engineering of new cattle breeds for higher milk productivity in India to understand how new technologies have to fit into existing social and environmental landscapes in India as much as they seek to transform them. More specifically, it shows how the upgradation of existing dairy cattle, through the use of artificial insemination techniques to produce crossbreds between European dairy breeds (Jersey and Holstein-Friesian) and indigenous Zebu varieties, reflects both the modification of local systems of production in accordance with national and international designs for dairy development as well as the dependence of development outcomes on contextual constructions of rural work. In the process, crossbred cows draw attention to the complicated meanings of engineering since their dissemination is involved with wider histories of colonial and postcolonial development as well as the role of household-level gender relations in the shaping of rural livelihoods. In India, new cattle breeds have the potential to disturb

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existing articulations between agriculture and dairying, leading to an imposition of the values of dairy development even as farmers assign different and wider meanings to cattle. Diverse linkages between science, technology, and society are thus implicated in dairy development revealing the extent to which meanings of engineering emerge in implementation. By juxtaposing the meanings of crossbred and indigenous cattle in India, this chapter aims to highlight the complexities of the engineering of rural natures and extend current understandings of megaengineering in three ways. First, dairy development provides a means to rethink the connection usually made between the scale of the engineering intervention and its consequences. Studies of environmental transformations have usually focused on how megaengineering projects, from large dams to superhighways, have radically altered existing ecosystems and social relations dependent on them. Given that dairy development in India is focused on cooperatives organized around village level producers, it is not a large project that reaches into smaller places, but instead has served to knit together a number of small producers to build collective strength (Kurien, 1997). Yet, village-based cooperative dairying does not simply turn out to be the opposite of megaengineering. Rather, through the promotion of improved cattle breeds, the collective structure has been utilized to extend the reach of development planning and build economies of scale that are key to capitalist accumulation. India's dairy development program is thus an opportunity to reflect on how seemingly small-scale development interventions are transformed by their technological accompaniments into the very megascale structures that were sought to be opposed in the initial stages of their conceptualization.

Second, dairy development enables a link between the extraordinary aspects of engineering and the everyday activities that underpin this extraordinariness. India's dairy program highlights the participation of women in dairying as part of its self-representation as a program that empowers marginalized social groups. Yet, the processes through which women's labor becomes available for dairy development are rarely highlighted, even as women's labor is a crucial component of the ability of rural households to incorporate dairy cattle in their everyday routines (ESCAP, 1981). The link between new forms of engineering and existing social relations can thus be followed through a focus on dairy development, pointing to the ways in which megaengineering is produced not just through official acts of development, but also through everyday acts of production and reproduction within local contexts (Agarwal, 1985).

Third, dairy development demonstrates the ways in which megaengineering projects do not embed themselves in a pristine landscape, but encounter earlier forms of engineering, in the process further heightening the changes unleashed by new technologies (Arnold & Guha, 1995). The maintenance of dairy cattle, for instance, is dependent on access to agricultural resources, and the intensification of agricultural operations as a consequence of the Green Revolution has the potential to both impede as well as enable this access. The precise manner in which Green and White Revolution technologies intersect with one another is thus a significant part of the explanation for the adoption of crossbred cows. A historical approach in this way becomes key to understanding the impacts of mega-engineering, so that

instead of isolating various innovations, their interactions with one another need to be considered.

As prelude to the specific discussion of dairy development, the next section locates existing understandings of the utilization and manipulation of animals within broader understandings of the engineering of nature through colonial power relations and industrial production. This is followed by an examination of policies related to the adoption of European dairy breeds within national dairy development in order to reflect on the equivocal support for crossbreeding with foreign breeds within national planning. The chapter then delves into relationships between crossbred cows and local agricultural practices in order to outline how changes in the breeding of cattle require changes in locally prevalent economic and social meanings of cattle. In the process, the dairy development program's turn towards strict separations between agricultural and dairying economies can be clarified, as well as the reasons for such separations not being wholly acceptable within local contexts. Crossbred cattle, however, do not only reflect the consequences of engineering, but also become key to understanding how engineering draws strength from already existing household level social relations on the one hand, and physical infrastructures on the other, and these aspects are followed in the remainder of the chapter. Overall, the aim is to understand the forms and outcomes of megaengineering projects in terms of their contextual reconstructions and not merely as manifestations of the power of technical expertise.

13.1 Animal Natures and Human Engineering: From Colonial Histories to Contemporary Industrialization

The study of human-environment relationships has recently been reinvigorated by interdisciplinary approaches to the meanings of "nature," moving from a long standing focus on scientific measurements and regional descriptions towards analyses that situate nature within historical and cultural frames of meaning. Environmental history has been useful in extending such understandings by relating colonial power relations and contemporary landscapes through notions of ecological imperialism, thus tracing the current distributions of plants and animals to environmental exchanges set in motion by European voyages of exploration, and intensified through the reshaping of landscapes to suit colonial commercial and political interests (Crosby, 1986; Grove, Damodaran, & Sangwan, 1998). Focusing on more recent forms of industrialization and commodification of nature, scholars across various disciplines have drawn attention to scientific endeavors that seek to match the rhythms of nature to the continuous need for monetary profits, leading to an intensive manipulation of natural properties which often blurs the boundaries between human and social natures (Castree, 2005). Alongside, cultural studies of nature have culminated in understandings of society that do not solely privilege human endeavor, since contemporary landscapes are not completely saturated with human presence but are also crucially dependent on the harnessing of the power and properties of animals and plants (Anderson, 2003).

The most striking studies on the engineering of nature have been provided by historical analysis of the construction of large scale water control projects in India and the U.S. As Worster (1985) has argued in the context of water control in the U.S. West, American projects sought from the start to imitate British colonial projects in India and Egypt, and hence were indelibly linked to imperialist strategies. This desire to control nature could be fulfilled only through a corresponding control over society, and large scale manipulation of water served mainly to concentrate the ability to distribute natural resources within the confines of agencies linked to the state. The link between environmental control and social control is thus a crucial aspect of understanding the implications of megaengineering projects. Since contemporary development in India has proceeded through a firm embrace of modern forms of agriculture and industry, including large scale water control projects, heavy industrialization, and an overall emphasis on adopting new forms of science and technology, colonial projects of environmental and social manipulation can be viewed as continuing into the postcolonial context (D'Souza, 2006).

Gilmartin (1995), however, has argued that large scale projects had contradictory meanings within colonial India. On the one hand, they justified control over Indian society in terms of the colonial regime's ability to implement large scale manipulations of nature; on the other, environmental changes consequent to large scale projects led to the formation of new social identities that threatened to elude the control of colonial authorities. This chapter seeks to add complexity to the position that nature cannot be modified without transforming the social itself by arguing that the relative flexibility of the social is also key to enabling the engineering of nature. In the case of crossbred cows, the possibility of drawing on existing gender divisions of labor becomes crucial to enabling the acceptance of improved dairy breeds. Yet, the objective here is not to downplay or nuance the power of engineering, as much as to highlight the complications that are introduced into discussions of human-nature relationships when the object of engineering is situated at the boundaries between the social and the natural (Mitchell, 2002).

Criticisms of technological transformations have often led to calls for a return to traditional forms of nature-based livelihoods and an emphasis on the ways in which local communities continue to maintain more sustainable agrarian traditions in the face of change (Shiva, 1988). Crossbred cows, since they explicitly require an incorporation of European breeds, are especially susceptible to this form of argumentation. Given that India's dairy program favors intermixing of cattle breeds and not substitution of one by the other, it can be argued that the program anticipates possible attacks on use of foreign breeds. It is also clear, however, that some segments of rural India have not wholly rejected modern forms of either agriculture or dairying as evidenced by the spread of Green Revolution technologies and dairy cooperatives. In his study of the Green Revolution, Gupta (1998) shows the ways in which modern forms of agriculture have become key aspects of contemporary rural identity, so that the technologies of the Green Revolution articulate with existing forms of agricultural and ecological knowledge. The need therefore is to steer a course between pragmatic and critical evaluations of development in order to reflect on the ways in which the clearing of space for new forms of engineering is both

a local and a global process. In the case of the adoption of crossbred cows, this requires an understanding of the ways in which the science of breeding through artificial insemination changes the very meanings of cattle, but also fits into the ways in which rural producers are reworking their identities in the face of access to Western knowledge and potential participation in global markets.

In terms of livestock development, the manipulation of the bodies of chicken to produce an entity that is solely devoted to meat production has been the subject of much critical analysis (Boyd and Watts, 1997; Dixon, 2003). Here the focus is on problems associated with industrializing the chicken, for instance, the susceptibility to disease within chicken coops which are tackled through antibiotics that are potentially harmful to human systems. This has also led to reflections on whether the industrialized chicken should be viewed as a completely new form of animal, given the ways in which it has been bred purely to enhance its commercial meanings. The wider social structures within which the industrial production of chicken has exponentially grown also draws attention to problems with contract farming and the complete takeover of the chicken commodity chain by agribusiness firms. While the Indian crossbred cow may not be as industrialized as the American chicken, the desire to transform a traditional animal into a commercial entity focused exclusively on milk productivity can also be followed through the development of the crossbred cow.

New forms of the engineering of rural natures can thus be situated within longer histories of colonialism, continuing moves towards the deepening of industrial systems of production, and advanced forms of manipulation of nature that are promising to become even more prevalent in the future. Alongside, engineering produces new modes of social control, but is also likely to be reshaped within the social context towards which it is targeted leading to the emergence of new social identities. Before we embark on examining these new forms of control and resistance, the next section follows the history of dairy development in order to draw out the meanings of crossbred cows within the wider context of centralized planning in India.

13.2 Rural Dairying and National Development in India

The trajectory of development in India can be traced through the central government's Five-Year Plans (Planning Commission, 2009), which combine a focus on sectoral allocation of funds with policies to alleviate regional inequalities. Within these Five-Year Plans, a continuous interest in cattle development can be clearly discerned, along with a constant wavering across various Plan periods regarding the best locations for the commercialization of animal products and the kinds of animal species that should be promoted (Chakravarti, 1985). In the early period of planning, in the 1950s, the emphasis was on locating dairy enterprises within cities or close to cities in order to serve urban consumers. The establishment in 1959 of the Delhi Milk Scheme (DMS) designed to serve consumers in India's capital is one

prominent example of the focus on urban milk producers, which was sought to be extended over time to other urban areas. Improving the quality of dairy animals, however, was viewed as best undertaken within rural areas, as exemplified by the Key Village Scheme (KVS). At that time, dual purpose cattle breeds, those which could be utilized for both draft and dairying purposes, were promoted as best suited to the needs of Indian farmers. In the 1960s, the KVS was supplemented by the Intensive Cattle Development Project (ICDP) which specifically sought to improve indigenous breeds of dairy cattle and buffaloes, and resembled in its area-specific approach the Intensive Agricultural District Program (IADP) geared towards the diffusion of high-yielding seed varieties.

By the 1960s, crossbreeding with high-yielding dairy cattle of European origin made an appearance in Plan documents. The extent to which this introduction of crossbred cattle responded to the needs of Indian farmers or merely reflected the technological biases of international development has become one of the central debates in evaluations of India's dairy development program. This shift towards increasing the productivity of dairy cattle was simultaneously accompanied by a revamping of the institutional structure of dairying in India, exemplified by the substitution of an urban, or at least suburban, model of dairying with a national dairying model focused on the formation of rural producer cooperatives. The formulation of a national dairy model can thus be viewed as providing a stable framework for the diffusion of crossbred cows.

The task of replicating cooperative dairying throughout rural India was entrusted to the National Dairy Development Board (NDDB) established in the small town of Anand in the state of Gujarat in 1965. This decision to locate the NDDB in Anand was deliberate, since the dairy cooperatives to be replicated were modeled on the Kheda District Cooperative Milk Producers Union (KDCMPU) which served villages in central Gujarat's Anand and Kheda districts (Anand district was previously part of Kheda district and became a separate entity in 1997). The KDCMPU itself was the outcome of a struggle launched in 1946 by farmers from villages around Anand. Protesting the control of milk marketing by Polson, a private dairy company favored by the British colonial regime, Anand's farmers soon won the right to organize milk production and marketing around their own cooperatives. This struggle also entailed opposition to small-scale milk traders, thus becoming a larger movement for farmer-control over the milk business. The subsequent success of the KDCMPU was underlined by the popularity of its products, sold under the brand name Amul, within urban markets. Such popularity could partly be linked to a highly visible advertising campaign as well as to the cooperative's ability to gain access to the metropolitan market of Mumbai (then Bombay). Thus, the institutionalization of the Anand model via the NDDB meant that a situated success story was sought to be extended across space, and a local movement was subsumed into the wider landscape of national development.

The NDDB's program of replication, dubbed "Operation Flood," was officially launched in 1970 and combined the social justice agenda of cooperative dairying, based on serving small farmers and alleviating rural poverty, with an emphasis on the expertise of engineers and managers seeking to meet the needs of dairy plants

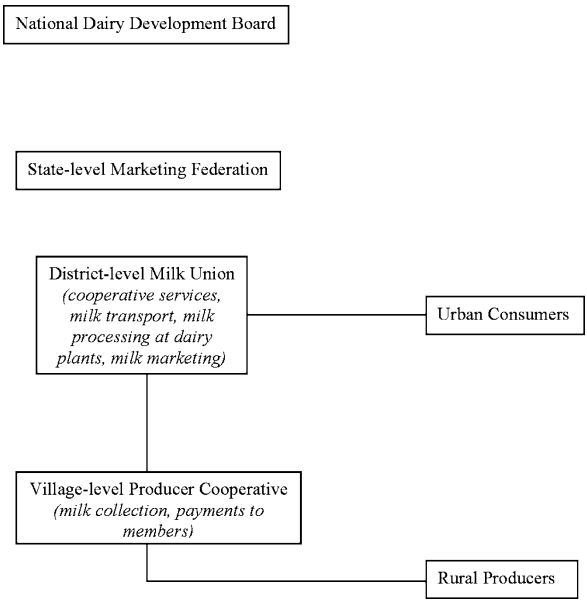

Fig. 13.1 Schematic representation of the Anand model of dairy development

and capture a larger share of the urban market. At the core of the Anand model of dairying were rural producer cooperatives linked to collection of milk at the village level and processing and marketing of milk at the district level. The dairy development program drew on this to build a three-tier institutional structure connecting village-level cooperatives, district-level unions, and state-level federations (Fig. 13.1). While strongly supported by the state, the NDDB was a parastatal organization, and thus a semblance of independence from state control in favor of farmer control was a significant aspect of its institutional ethos. The other prominent aspect of the program was the linking of rural producers to urban consumers, so that the Anand model was based on enhancing milk production in rural areas and milk consumption in urban areas. While this meant that urban dairying was officially discouraged under the Anand model, program officials insisted that rural consumption of milk was not correspondingly depressed as a consequence of the focus on urban markets. The emphasis on urban consumers however has remained a much criticized aspect of the program (George, 1985).

Funding to replicate village-level cooperatives across rural India was to a large extent provided by the European Economic Community (EEC) and the World Bank, which further solidified the value of dairy cooperatives within national development. In 1969, the EEC, via the United Nations World Food Program (WFP), had sought to provide excess dairy products as food aid to India, a move which had the potential to undercut Indian dairy production. The NDDB was instrumental in ensuring that proceeds from sales of EEC dairy products were channeled into the replication of cooperative dairying, so that EEC aid promoted the national dairy development program, instead of competing against it for urban consumers.

At around the same time, India's dairy program began to promote dairy production techniques prevalent within advanced dairying countries, most evident in the shift towards cattle breeds that were exclusively geared towards dairying as opposed to the dual purpose breeds more popular in India. Crossbreeding with exotic breeds was explicitly mentioned as an option for the improvement of dairy cattle in the Third Plan, 1961–1966 (Planning Commission, 2009). The World Bank, which funded the replication of cooperative dairying in three states in India from 1974 to 1996, was also supportive of the move towards crossbred cows. Thus, in Bank-led evaluations of state-level cooperative initiatives, the extent of acceptance of crossbred cows became a key factor, feeding into a larger emphasis on the commercialization of cooperative dairying services, including veterinary support, artificial insemination, and transportation (Candler & Kumar, 1998; Mergos & Slade, 1987).

Critics have argued that the adoption of new dairy technologies was driven by the alliance between Western donors and national development officials rather than by the needs of rural people (Baviskar & George, 1988; Baviskar & Terhal, 1990; Doornbos, van Dorsten, Mitra, & Terhal, 1990). The promotion of crossbred cows came under special attack since dairy farmers, in Anand and across many parts of rural India, utilized buffaloes as dairy animals. Thus, the coincidence between the 1960s–1970s turn towards crossbreeding with exotic breeds and the utilization of international funding for Operation Flood was viewed as the loss of local control. An activist campaign launched in 1985 in the Netherlands to prevent the Dutch government from promoting crossbreeding programs in India provides evidence of the wider opposition that accompanied the shift towards European dairy breeds (ICN, 1985).

However, even as crossbreeding appeared in India's plan documents around the time of Operation Flood, there is a longer history of crossbreeding within India. In the early 1900s during British colonial rule, military dairy farms had been sites for experiments with crossbreeding between exotic and indigenous cattle breeds (Banerjee, 1994). By the 1960s, the Green Revolution had enabled new forms of breeding and higher productivity to be situated within a wider framework of utilizing technological advances to promote rural development. Moreover, the first act of the farmers of Anand had been to hire a U.S. trained engineer, Verghese Kurien, to manage their dairy operations, which seemed to indicate a desire to benefit from new dairy technologies and expertise. It must also be noted that crossbreeding policies from the beginning sought to maintain exotic content at a level of 5/8th, so that the aim was not to produce a purebred exotic dairy cow, but to enable sufficient mixing so that the new form of cattle was suited both to higher productivity as well as climatic conditions in India (Tandon, 1951). Thus crossbred cattle, including European crossbreds, cannot be automatically considered to be either foreign to Indian dairying contexts or completely unacceptable to farmers.

The larger issue in the debate over crossbreeding, however, is the ways in which new technologies prevent wider forms of participation in dairying. In other words, how do crossbred cows fit into existing class and gender divisions in rural India? Will the avowed objective of cooperative dairying to serve the interests of small

producers become lost in the desire to improve the productivity of dairy cattle? This becomes an especially urgent question since the liberalization of the Indian economy in the 1990s, impelled in immediate terms by a balance of payments crisis, but more broadly precipitated by pressures from both international development agencies and domestic industrial interests (Pedersen, 2000). For state-led dairying, which had been protected from foreign competition since the 1950s in order to ensure the growth of the cooperative sector, liberalization has meant a loss of privilege within the national landscape of development as well as a potential loss of rural producers to private dairy companies. While the full impacts of dairy liberalization and consequent privatization have yet to be experienced by cooperatives, it is likely that a greater emphasis on productivity and profits as opposed to serving small dairy producers will lead to spiraling pressures on farmers to adopt more technology-intensive forms of dairying (Rajaram, 1996; Sharma & Gulati, 2003; Singh, Coelli, & Fleming, 2001; Vyas, 2002). Crossbred cows are thus likely to become even more central to future forms of dairying than they are currently.

As can be seen in Fig. 13.2, milk production in India has registered a substantial increase from the 1950s onwards. Thus, the 17 million tons of milk produced in 1950–1951 increased to 80.6 million tons by 2000–2001. In fact, the rate of increase shows a marked rise between 1980–1981 and 2000–2001, with a relative change of 155% across this time period. Two econometric studies that seek to explain this increase provide insights into processes of milk production in India. According to Munshi and Parikh (1994), the rise in milk production in India can be explained by an increase in number of cooperatives, as opposed to direct technical inputs which in their study is measured by increase in the use of cattle feed. They attribute this

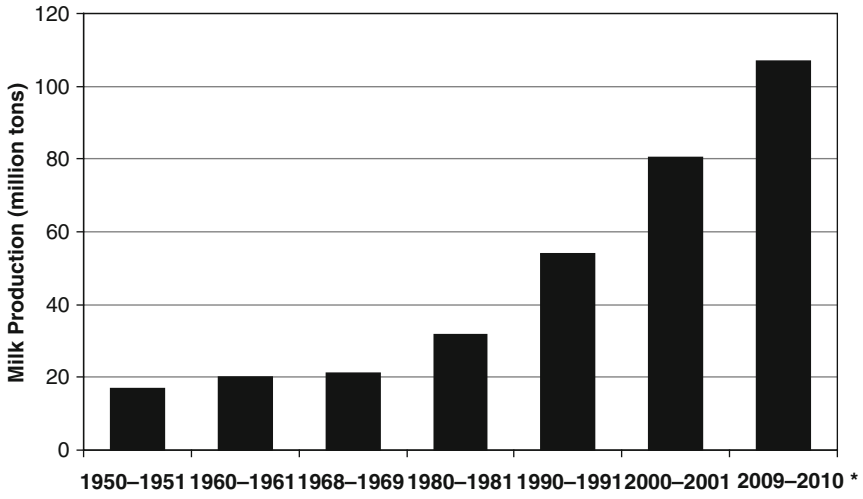

Fig. 13.2 Total milk production in India, 1950–2010 (in million tons). (*Figures for 2009–2010 are estimated) (Source: Dairy India 2007: 102)

finding to the fact that "the cooperative system may serve as a channel for the dissemination of information, facilitating a broad learning process in the industry, as well as provide an infrastructure base for the adoption of new technology" (p. 222). Candler and Kumar (1998), in a report published under the auspices of the World Bank, attribute increased milk production to technological progress. Since prices paid to dairy farmers have only marginally increased over the period of the World Bank's funding of cooperative dairying, rise in milk production shows that farmers have been able and willing to produce larger quantities of milk without stimulation from market prices. In both studies, the cooperative dairy program thus becomes key to enabling increased milk production. The number of dairy cooperative societies shows a marked increase from the 1980s, which is a decade after replication of rural dairy cooperatives through Operation Flood was launched, to the mid-2000s (Dairy India, 2007: 116).[2]

The significance of rural cooperatives in milk production however has to be juxtaposed with the continuing predominance of the unorganized sector in milk marketing. According to Dairy India (2007), 98% of total milk production in India occurred among rural producers in 2005. Out of this production, approximately equal amounts of milk were retained for consumption within rural areas and sent on to be marketed to urban consumers. But only 9% of the milk available for marketing was controlled by cooperative and public dairies compared with 36% of the total production being handled by the private sector. This difference has been explained in terms of continuing allegiances by rural producers to private traders who often set up personal relationships of financial and social support that cannot always be replicated by dairy cooperatives (Hiremath, Singh, & Mergos, 1997).

In terms of dairy animals, the relative utilization of cows and buffaloes for dairying varies regionally across India, both in terms of urban-rural divisions and in terms of state-wise distribution. Overall, as shown in Fig. 13.3, cattle exceed buffaloes in terms of total numbers, yet in terms of rates of growth, cattle numbers have steadily declined from 1982 to 2003, while buffaloes show an increase over the same time period. Table 13.1 shows a comparison of the rate of change in numbers of cattle and buffaloes between urban and rural India. It becomes clear here that rates of change differ by type of cattle, so that crossbred cattle have registered an increase across both urban and rural contexts, while non-crossbred cattle show a decrease, especially in rural contexts. Buffaloes, on the other hand, have grown in number between 1992 and 2003, especially in urban areas. The loss of cattle and increase in number of buffaloes has been taken to imply the decreasing use of cattle as draft animals with a corresponding increase in dairy animals, especially buffaloes. The increase in crossbred cows reflects a similar turn towards dairy animals.

Milk production by species also shows regional variations in India. About 17–18% of total milk production is by crossbred cows, while 54–55% is produced by buffaloes (Table 13.2). As can be seen in Fig. 13.4, states in northern and southern India show the highest production of milk in terms of absolute numbers. Yet, when Fig. 13.4 is compared to Fig. 13.5, it becomes clear that the share of crossbred cows in milk production is not very high. Thus, milk production by crossbred

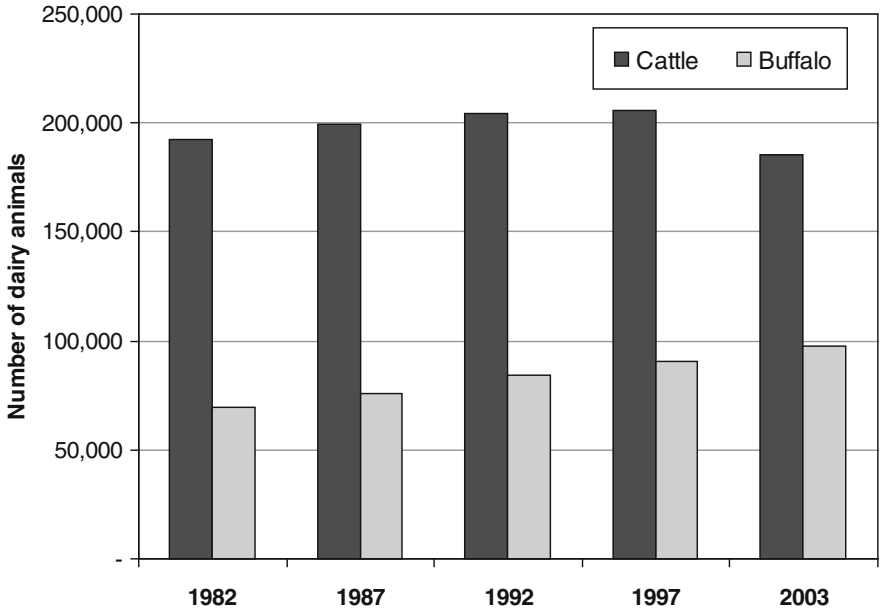

Fig. 13.3 Comparison of numbers of cattle and buffaloes, 1982–2003. (Source: Dairy India, 2007: 111)

Table 13.1 Change in rural-urban distribution of cattle and buffaloes, 1992–2003

		Rural	Urban	Total
1992	Crossbred cows	13,462	1,753	15,215
	Non-crossbred cows	182,425	6,944	189,369
	Buffaloes	79,915	4,291	84,206
2003	Crossbred cows	21,937	2,750	24,686
	Non-crossbred cows	153,714	6,780	160,495
	Buffaloes	91,930	5,993	97,922
Change (1992–2003)	Crossbred cows	62.95%	56.87%	62.25%
	Non-crossbred cows	–15.74%	−2.36%	−15.25%
	Buffaloes	15.03%	39.66%	16.29%

cows approaches relatively appreciable levels mainly within states in south and northeastern India. One possible explanation for the higher adoption of crossbred cows in southern India is a shift away from mixed agro-dairy production to pure dairy production which enables the shift to crossbred dairy cows (Nair, 1990a). This explanation could also hold for states of northeastern India. Additionally, northeastern states produce relatively low levels of buffalo milk so that the percentage of milk produced by crossbred cows counts for a larger proportion of total milk produced, and have also been the target of the Integrated Dairy Development Plan (IDDP)

Table 13.2 Proportion of total milk produced (in million tons) by cattle and buffaloes, 1995–2004

	1995–1996	1999–2000	2003–2004
Cattle	30.0 (45.3%)		
Crossbred cows		13.6 (17.4%)	15.6 (18.0%)
Non-crossbred cows		19.0 (24.3%)	19.4 (22.4%)
Buffaloes	32.6 (52.0%)	42.3 (54.0%)	48.0 (55.3%)
Total milk production	66.2 (100.0%)	78.3 (100.0%)	86.7 (100.0%)

Dairy India (2007: 102, 109)

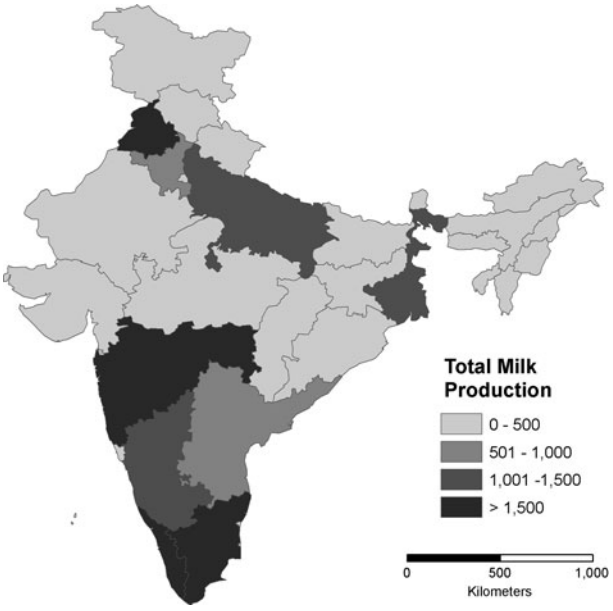

Fig. 13.4 Total milk production from cattle and buffaloes, 2003–2004 (in thousand tons). (Source: Dairy India, 2007: 109)

which focused on improving dairy production in non-Operation Flood, hilly, and tribal districts and states.

Given the current distribution of crossbred cows, there are two possible trajectories in terms of future diffusion. In one scenario, India's northern states which comprise the center of its dairy economy could also begin moving towards commercial dairy production and hence towards the adoption of crossbred cows. At the other extreme, the adoption of crossbred cows could continue to show a marked southern bias leading to a division between northern and southern India, with the former continuing to be dependent on buffalo-based dairying and the latter moving further towards crossbred cow dairying. The most recent Eleventh Five-Year Plan, 2007–2012 (Planning Commission, 2009) shows that the emphasis on crossbred cows is likely to be extended into the future. Thus, the Plan mentions the continuation of a program which focuses on "genetic up gradation of indigenous

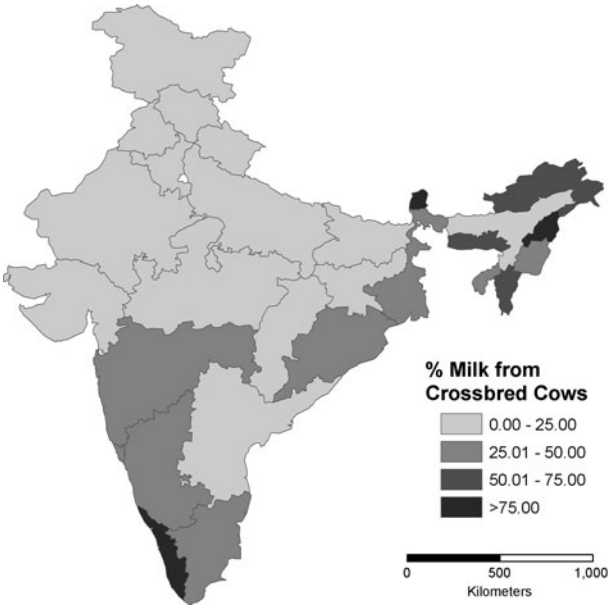

Fig. 13.5 Proportion of total milk production from crossbred cows, 2003–2004. (Source: Dairy India, 2007: 109)

cattle and buffaloes, development and conservation of important indigenous breeds and [the evolution of] ... sustainable breeding policy" (Vol. 3: 11). The juxtaposition of "up gradation" with "conservation" can be viewed as consistent with the more critical approach towards "indiscriminate" crossbreeding with exotic breeds in the Tenth Plan, 2002–2007 (Planning Commission, 2009). Thus, the Eleventh Plan mentions the need to diffuse artificial insemination services to upgrade cattle breeds, but does not specify if the upgradation necessarily involves crossbreeding with European dairy breeds. It is highly likely however that the emphasis on the inculcation of the characteristics of foreign breeds will continue despite this silence. As will be examined in the next section, the meanings of crossbred dairy cows differ substantially from existing values of cattle in rural India. Such differences highlight the ways in which the engineering of dairy cattle also necessitates an appropriation and transformation of the social relations that underpin and continue to characterize rural, agricultural livelihoods.

13.3 Old and New Meanings of Cows: Labor Value and Cash Value[3]

While official policies and their outcomes portray an equivocal relationship with the potential of European dairy breeds, the reasons for the uneven adoption of crossbred cows become more clarified in terms of local agricultural practices. Generally speaking, farming systems in India can be considered mixed in two ways.

First, agriculture largely combines subsistence and commercial cultivation, especially since the majority of landholdings continue to be small in size (Das, 2007). Second, in most farm households, dairying operations are conducted in conjunction with agriculture, so that agricultural resources subsidize the maintenance of dairy animals. The introduction of crossbred cows geared exclusively towards milk production for the market works against both forms of mixed farming. There are two aspects, therefore, to dairy development based on crossbred cows. In terms of the commercial-subsistence combination, crossbred cows entail a dependence on specialized inputs which increase the costs associated with maintaining them. In terms of the agriculture-dairying linkage, crossbred cows do not fit into existing agrarian environments and comprise a separate dairy economy. These two aspects of crossbred cows will be examined in this section (Fig. 13.6).

Juxtaposing technologies promoted by the agricultural Green Revolution and dairying White Revolution, George (1990) points out the ways in which they combine to diminish actually existing synergies between agriculture and dairying. To begin with, the hybrid crop varieties promoted under the Green Revolution are unpalatable to cattle and hence cannot be used as fodder. This breaks the link between crop residues and dairy animals and ensures that households become dependent on buying cattle feed. Alongside, crossbred cattle promoted by the dairy development program cannot be used as draft animals, even as farmers continue to be dependent on animal power for their agricultural operations. Mismatches between new seeds and cattle and existing forms of agriculture and dairying thus mean that new technologies require a change in the conduct of rural livelihoods (Nair, 1990a).

Fig. 13.6 Crossbred cow in village in Gujarat. (Source: Author)

The most important transformation here is in terms of dependence on humped Zebu bullocks. As the Fourth Plan, 1969–1974 (Planning Commission, 2009) describes it, "the rate of progress in this respect [adoption of crossbred cows] will, however, depend upon the degree of the farmers' acceptance of cross-bred humpless animals as working stock" (Chapter 8, Section 10). In India, bullocks continue to be used for agricultural tasks, like plowing, planting, and weeding, as well as for transport. The ability to depend on animal power becomes even more crucial given the fuel costs associated with mechanization, costs that even relatively well-to-do farmers seek to avoid. In the season of rains, cattle also become the more dependable mode of transport, better able to negotiate unpaved roads than mechanized transport. Since Zebu bullocks are bred for physical strength, they are more suitable for draft labor than the dairy crossbreds. As can be seen in the poster promoting crossbred cows (Fig. 13.7), it is their use as draft animals that is actually illustrated which suggests that the dairy program is seeking to counter existing criticisms of crossbred cows.

The unwillingness to shift to crossbred cows for dairying purposes, however, is not linked only to the use of Zebu bullocks for draft purposes, but also arises due to a preference for water buffaloes as dairy animals. Even as the use of cattle and buffaloes varies across India in keeping with climatic regimes and regional traditions of agriculture, the maintenance of a separation between buffalo-based dairy economies and cow-based draft economies is a significant aspect of agrarian livelihoods in particular rural contexts. A cultural preference for buffalo's milk due to its higher fat content underlies the preference for buffaloes as dairy animals. Given that crossbred cows provide neither bullocks suitable for agricultural labor, nor milk that

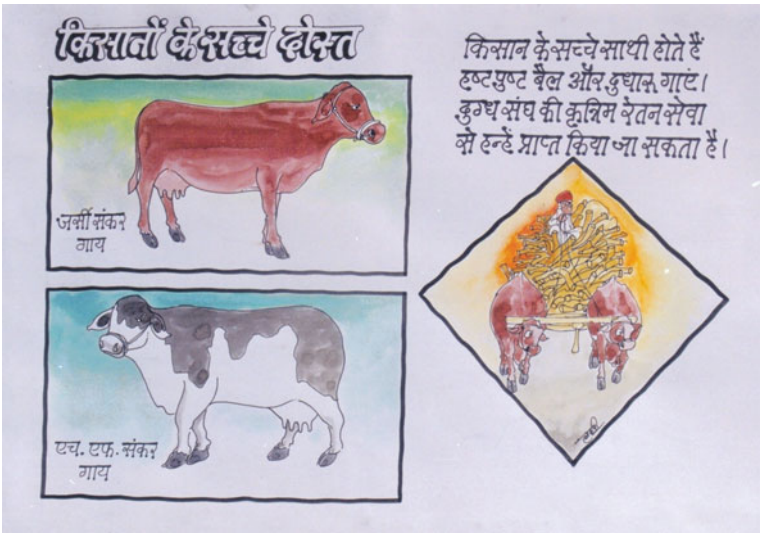

Fig. 13.7 Poster promoting Jersey and Holstein-Friesian crossbred cows as "true friends of farmers". (Photograph obtained from Indore Milk Union, Madhya Pradesh)

conforms to local uses, their value for local agriculture and dairying is often difficult to establish.

Lack of knowledge of crossbreds is another significant factor in their unsuitability for local agriculture. Zebu bullocks can be bought and sold at local cattle markets, but given that crossbred cows are not part of local economies, the ability to find buyers for them is uncertain. Moreover, knowledge related to diseases and treatments in Zebu cattle is usually available locally. The maintenance of crossbred cows, on the other hand, requires access to specialized veterinary knowledge. Similarly, access to artificial insemination materials and techniques is provided by the dairy program, and breeding can no longer be undertaken on the basis of village-level knowledge and resources. Crossbred cows therefore are dependent on services provided by the cooperative, and the resultant shift in control over dairying to sites and experts outside the village highlights the foreignness of crossbred cows and makes village-level dairying a matter of gaining access to the largesse of development officials. As can be seen in the poster promoting artificially inseminated cattle, the service provider is dressed differently from the farmer and the incorporation of the motorcycle of the service provider further underlines his outsider status (Fig. 13.8). In the context of the village, however, it is local dairy cooperative employees who are trained in artificial insemination (Fig. 13.9), both bringing specialized knowledge within the purview of the village but also setting the stage for possible monopolization of cattle-related knowledge within the realm of the cooperative.

Fig. 13.8 Portion of poster promoting artificial insemination of cattle. (Photograph obtained from Indore Milk Union, Madhya Pradesh)

Fig. 13.9 Artificial insemination station in village in Madhya Pradesh. (Source: Author)

Besides veterinary and insemination services the dairy cooperative is also a source for cattle feed. The shift from local sources of fodder to prepared cattle feed is imperative to maintaining the higher yields of crossbred cattle, and to ensure year-round nutrition in the presence of seasonal variations in access to green fodder (Nair, 1990b). Yet, to buy cattle feed is also to add to the costs of crossbred cows, and these costs become burdensome in a context where cattle and buffaloes have traditionally been fed on weeds and post-harvest residues, as much as on specially planted fodder crops. The system of dependence between agricultural crops and dairy animals is thus truncated by cooperative dairying when the aim of the program is higher milk yields and not household-level self-sufficiency.

An important aspect of the feeding of dairy animals is linked to grazing. What distinguishes crossbred cattle from Zebu cattle and buffaloes is that crossbreds have to be stall fed even when they are not pregnant or lactating. The usual practice in rural India is to graze cattle and buffaloes on one's own fields or on commonly owned grazing land. Since labor requirements for grazing are much lower than for stall feeding, crossbred cows also stretch household labor availability. Further, not only does fodder have to be brought to crossbred cows, their dung also has to be carried to agricultural fields. Grazing has the added advantage of spreading animal manure on agricultural fields, and preventing excess accumulation near cattle sheds. In many ways, then, the restriction of crossbred cows to the space of the cattle shed

changes the geographies of dairying and dairy-related labor, and these changes may not be feasible for, nor acceptable to, all rural households.

Without doubt, however, the output of crossbred cows far surpasses that of local breeds of cows and buffaloes. The higher yield of crossbred cows becomes even more advantageous due to its lack of seasonality. For dairy plants, therefore, crossbred cows ensure that milk procurement can better approach milk processing capacity. However, while the quantity of milk produced by crossbreds is high, its fat content is much lower than buffalo milk. Given that milk is paid on the basis of both quantity and fat content at the village cooperative, buffaloes are often viewed as more economically advantageous. The tradeoff between the higher quantity of milk produced by crossbred cows and the higher fat content of buffalo milk is further resolved in terms of the latter when the size of the dairy herd is small, and given that higher production in crossbreds is also linked to higher costs in terms of feed and veterinary services.

In such predominantly economic discussions of the differences between Zebu cows, crossbred cows, and buffaloes, religious values attached to cows within Hinduism do not directly intervene. Yet, to the extent that the slaughter of cattle and buffaloes is not mentioned within the dairy development program as a way to augment the financial value of dairy animals, the program adheres to popular Hindu norms. While there were some attempts to officially ban the slaughter of cows in India, no actual law has been passed to this effect at the level of the central government (Noronha, 1994), except to the extent that states have the freedom to make their own laws regarding cattle slaughter and transport of cattle across state lines is often illegal (Krishnakumar, 2003). The use of buffaloes as dairy animals could be a consequence of this animal being relatively less sacred than the cow, so that less productive animals can be more easily disposed. There has been no study as yet of this issue, or of the extent to which the sacred meanings of Zebu cattle are transferred to crossbred cows, though there is no indication that this is not happening. In some ways then, the commercialization of dairying, but not meat production, both conforms to hegemonic Hindu principles as well as maintains a secular aura since the program emphasizes productivity without bringing in religious ideals.

Overall, commercial dairy development in India is partially stymied by the fact that cattle and buffaloes are valued in India for their labor power as well as for the cash value of their milk. To the extent that profits from dairying are not the main consideration in terms of local participation in cooperative dairying, as much as the utilization of already existing agricultural outputs, the higher yield of crossbred cows is often not sufficient to propel local farmers towards adopting crossbred cows. Moreover, rural India continues to be characterized by small farmers who own very few dairy animals, so that the higher costs associated with crossbred cows are not feasible for the bulk of its population, unless these costs are subsidized by cooperative dairying. The dairy program was established to ensure that small milk producers have access to milk markets, so that the shift towards greater commercialization signified by improved breeds does not conform to the original model. Since crossbred cows are purely oriented towards the needs of commercial dairying, with cash incomes juxtaposed against higher expenses, they do not fit into rural systems

that work through subsidizing dairying by connecting it to one's own agricultural fields.

13.4 Linking New Technologies to Household Work: Gendered Meanings of Crossbred Cows[4]

The link between crossbred cows and agriculture is not the only factor that shapes their adoption. What is also a crucial component is the labor associated with maintaining crossbred cows, labor that is viewed as being principally provided by women. In other words, the gap between existing agricultural practices and crossbred cows is often filled in through women's work, so that the gender division of agricultural and dairying tasks enables the adoption of crossbred cows by rural households. In an early discussion of dairy development, a UN conference which focused on women and dairying (ESCAP, 1981), feminist scholars had argued that the adoption of both hybrid seeds in the Green Revolution and crossbred cows in the White Revolution is dependent on the inclusion of women in development. Critics of the dairy development program, however, have argued that the program has achieved exactly the opposite—by taking over processing and marketing tasks previously performed by women, cooperative dairying in fact has reduced women's control over household-level dairying and hence disregarded their dairying knowledge (George, 1985). Yet, this does not mean that women's work within cooperative dairying has decreased. In fact, studies of the amount of labor expended on household dairying have shown that dairy development has increased women's work burdens and thus is dependent on the exploitation of women's household labor (Mies, 1986; Mitra, 1987).

Even as criticisms of the mode of women's incorporation into dairy development are valid, it is also worth reflecting on why women continue to contribute their labor to dairy development despite both increased responsibilities for work and loss of control over dairying knowledge. In Candler and Kumar's (1998) evaluation of India's dairy development program, they argue that dairying work is preferred by women since it can be conducted at home and is more remunerative than agriculture. In contrast, feminist scholars have argued that women's participation has to be viewed as a pragmatic strategy—in the absence of other avenues of employment, cooperative dairying becomes a valuable option for women (Sharma & Vanjani, 1993). This is not to argue that women's work is freely chosen by them, or that women's household-level work is not determined by patriarchal power, but that the gender division of labor is a historically contingent outcome and women's connections with dairy development are likely to change over time. Thus, declining returns from Green Revolution agriculture especially on small pieces of agricultural land, as well as the need for access to ready cash in an increasingly monetized everyday economy, have to be considered as the larger factors shaping women's dairying work. Currently, the crisis facing rural India makes steady income from dairying, in conjunction with the ability to subsidize dairying costs through access to some amount of land, an attractive option for households and for the women within them.

In the case of crossbred cows, the availability of women's labor becomes especially crucial since stall-feeding has to be regularly undertaken. Women's work, either in terms of weeding or the actual cutting of fodder, bridges the distance between cattle sheds and agricultural fields. The immobility of crossbred dairy cattle is thus countered by the mobility of women's work. It is also worth noting that women's dairying enables the drawing of value from small land holdings, which though not useful for agriculture can continue to function as sources of fodder. The withdrawal of women from agricultural work, in other words, does not result in a loss of connection with agricultural fields to the extent that women are involved in stall-feeding cattle.

Milking is also strongly viewed as women's work in many parts of rural India (Fig. 13.10). Yet, the higher yield of crossbred cows means that women's and men's labor has to be pooled within households to ensure timely milking. This sharing of work supports the notion that commercial dairy development in fact paves the way for the entry of men into the domain of women's work, and could possibly result in a takeover by men of women's options for income generation. Given this, local discourses which represent the work of dairying as women's work could in fact be strategies to ensure women's access to dairying income.

The gender division of responsibilities for animals is also a major part of the explanation for why crossbred cows become linked to women's work. Thus, the care and use of bullocks is men's responsibility, and women do not participate in

Fig. 13.10 Milking crossbred cow in village in Gujarat. (Source: Author)

the draft cattle economy. Given that crossbred cows do not have any draft uses, their suitability as women's cattle is further enhanced. Alongside, to the extent that draft cattle are replaced by mechanized vehicles and implements for plowing, irrigation, weeding, and harvesting, a large part of milk production becomes available for sale, being no longer required to nourish calves, so that the separation between men's work and dairying becomes even more pronounced.

Yet, even as crossbred cows have been fitted into women's work routines to counter the decline in agricultural incomes, it is also clear that women are not thereby provided with specialized knowledge related to the crossbred cow economy or cooperative management. Thus, the breeding of crossbreds is dependent on artificial insemination provided by the cooperative, the health of crossbreds is addressed on the basis of specialized veterinary knowledge, and the processing and marketing of milk occurs outside the village. A deskilling in relation to dairy animals is thus installed through the cooperative, and it is likely that the link between crossbred cows and higher incomes from dairying is emphasized in order to represent the loss of men's and women's knowledge as the economic empowerment of women.

An even more glaring gap between genders is in terms of responsibilities for buying and selling crossbred cows. Thus, as a crossbred cow market begins to emerge, it will also be dominated by men, in similar fashion to Zebu cattle and buffalo markets. The participation of women occurs therefore only in the context of the milk economy; women's responsibilities for crossbred cows do not extend beyond the cattle shed. From this perspective, crossbred cows maintain, even enhance, the power of scientists, engineers, and managers as well as of men in rural contexts, and women's key role in dairying tasks does not translate into participation within or control over wider animal economies.

The exclusion of women is also expressed in their absence from village-level cooperative boards. Even though, this has been sought to be corrected through the reservation of a certain number of seats for women, village-level administration of cooperatives continues to be in the hands of men, with women remaining absent from decision-making within the cooperative body. More recently, the political exclusion of women has been addressed through the formation of women-only cooperatives, and while these are probably more reflective of how dairying work is conducted within rural spaces, it is not clear if they will ensure women's participation in wider village-level politics.

There is a danger therefore that the link between crossbred cows and women will ensure that women continued to be burdened with the task of ensuring outcomes desired by the dairy development program, without gaining any appreciable political or economic power. The dairy program overtly links ability to profit from crossbred cows to women's willingness to maintain greater numbers of cattle, without regard to the economic and environmental constraints under which farming households operate, and without considering the ways in which the link between women and dairying builds on gender inequalities that exist within households and in development planning. More recently, women are being exhorted to ensure the quality of milk thus leading to the representation of hygienic milk production as part of women's larger responsibility for the maintenance of domestic cleanliness.

Here again, instead of including women in the construction of strategies to counter competition from private dairies and the wider consequences of neoliberalization for agricultural livelihoods, competitiveness is sought to be ensured through an intensification of women's responsibilities.

Overall, crossbred cows have to fit into gender divisions of agricultural and dairying tasks, which are already being modified due to the declining efficacy of Green Revolution technologies and the global competitions being faced by India's agricultural sector. Given the new forms and increased amounts of labor that have to be devoted to crossbred cows, women have become crucial to subsidizing the costs of dairy labor. Newly engineered cattle breeds are therefore dependent on household-level distributions of agricultural and dairying tasks, and women's work especially becomes key to the unfolding of dairy development in rural contexts.

13.5 Colonial Traces in Flows of Milk: The Physical Infrastructure of Dairy Development

The megaengineering of India's dairy sector is not restricted only to the body of the crossbred cow and attendant social transformations. Alongside, the wider physical infrastructure required for crossbred cow dairy economies is dependent on advances in transportation and refrigeration technologies. One major reason for the small town of Anand becoming the hub of India's dairy development program is its links to rail networks that knit together and underpin the development of India's metropolitan centers. In 1946, when the dairy development program was first being established, Anand was already part of a railway route constructed by the colonial British government as part of wider rail building initiatives, and dairy officials have highlighted the role played by long-distance rail networks in ensuring that Anand's cooperatives could access a larger milkshed. As comparative studies have shown, the success of Anand's dairy body, Amul, contrasts with the relative lack of success of milk production and marketing in other parts of India where the Anand model of cooperative dairying was replicated (Basu, 2009b; Mascarenhas, 1988), and transport networks are part of the explanation for this difference.

In the postcolonial period, the ability of the state of Gujarat to invest in infrastructural development has further enhanced the efficacy of Anand's cooperatives in coping with higher quantities of milk production. Thus, the quality of roads in the state ensures that transportation of milk occurs in a timely fashion and access to regular electric supply has enabled milk refrigeration facilities and automated machines for milk measurement to be installed within villages. Without access to such facilities, the cooperative system would not be able to cope with highly productive cattle. States within which infrastructure is relatively underdeveloped thus often show a lesser degree of success in cooperative dairying.

Another problem that follows transportation networks in India is that they are geared towards connecting rural resources to urban consumption. This link is especially true of rail networks which were built within a colonial regime that sought to

draw natural resources away from the interior of India towards port cities, and the contemporary transport of milk has conformed to this metropolitan bias. Thus, dairy development has not inaugurated a new geography of resource flow, but has ensured that milk flows conform to pre-existing colonial geographies of transportation. The engineering of new cattle breeds thereby becomes located within previous engineering designs, so that megaengineering projects build on one another, often exacerbating the social problems that accompanied previous technological designs.

As technologies cascade after one another, transport, refrigeration, processing, and breeding technologies are currently being enhanced by new information technologies. While the link between dairy development and information technologies is viewed as enabling further access by dairy farmers to knowledge regarding modern dairying techniques and the possibility of export to global markets, they also ensure that the dairy program promotes an intensely technological form of cooperative dairying that may not be feasible for all small producers and rural places. The ways in which competition between the cooperative program and private dairy companies will exacerbate the technological gap between dairying geared towards small producers and dairying geared towards productive cattle has to also be considered in the evaluation of new engineering designs. The turn towards crossbred cows is thus dependent on physical infrastructures that can cope with higher production, so that crossbred cows draw our attention to the wider histories of megaengineering within which new dairying technologies need to be located. In the process, dairy development becomes linked, not only to patriarchal power, as mentioned in the previous section, but also reflects traces of colonial power.

13.6 Conclusion: The Social Bases of Megaengineering

This chapter has located megaengineering not just within the characteristics of the actual technological innovation itself, in this case the body of crossbred dairy cattle, but also in the gendered social relations and colonial physical infrastructures that enable the new technology to make place for itself in local contexts. Overall, it can be argued that the logic of higher production through crossbred cows, the engineering logic, turns out to be very different from the logic of mixed, small-scale farming, in which dairying is a synergistic activity and not separate from agriculture.

Crossbred cows thus enable us to make three observations about megaengineering. First, India's dairy development program provides a means to understand how megaengineering operates under the cover of policies aimed at promoting the small-scale dairy producer. Moreover, while the crossbreeding program is an attempt to ensure that pure European breeds are not unleashed on the village, crossbred cows continue to have far ranging impacts in terms of agriculture, changing connections between agricultural and dairying operations into separations between the two. The consequences for local breeds of cattle and buffaloes are likely to be deleterious. As

agricultural options continue to decline, small farmers are likely to be further compelled to turn towards a crossbred cow economy that links them to the development program and loses its links to local contexts.

Second, dairy development shows how spectacular leaps in dairy engineering are ultimately dependent on their being fitted into the daily routines of gendered work within rural households. Thus, the process of converting crossbred cows to cash is smoothed by household-level gender divisions between agricultural and dairying tasks, with women's responsibilities for crossbred cows ostensibly chosen by them in a context where avenues to employment are becoming scarce, but also implemented under the shadow of patriarchal power. The engineering of dairy cattle is thus dependent on the spatial and social meanings of gender identities in rural India.

Finally, the effects of megaengineering projects are not linked solely to their own composition and characteristics, but are also built on interactions with past engineering initiatives. The higher milk of crossbred cows has to be efficiently transported and processed, and depends on the quality of already existing road and electric supply networks. In this way, the outcomes of dairy development become partly reflective of past colonial and contemporary inequalities in levels of economic development across India. More broadly, the meanings of megaengineering projects have to be situated at the intersections of technological, social, and environmental changes in order to grasp the complexities associated with their unfolding.

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Notes

1. The Green Revolution in India was inaugurated in the late 1960s and dominated into the early 1980s (Eleventh Five-Year Plan, 2007–2012, Vol. 3: 4 in Planning Commission 2009).Principal technologies of the Green Revolution include high-yielding seeds, increased dependence on chemical fertilizers and pesticides, access to large irrigation projects, and shifts towards mechanization (Byres, 1981; Glaeser, 1987; Harriss, 1982, 1972).
2. Dairy India is the authoritative source of information on India's public and private dairy institutions, providing both longitudinal data as well as current information on technologies and policies related to dairying. One of the sources utilized by Dairy India is the Census of Livestock, which has been conducted in India since the 1920s at five-year intervals. The counting of livestock by breeds, however, was not undertaken till the 2003 Census of Livestock, which is also the latest Census for which data are currently available.
3. The discussion in this section is partly based on dissertation-related fieldwork conducted in two villages in India over 2000–2001. Data were collected through household surveys, open-ended interviews, and participant observation. Results of the ethnographic study are available in Basu (2009a).

4. The discussion in this section is also partly based on dissertation-related fieldwork conducted in two villages in India over 2000–2001. More specific considerations of the links between gender and dairy development are available in Basu (2009b, 2006, 2005).

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