

BAIF Research Highlights

2001-2007



BAIF DEVELOPMENT RESEARCH FOUNDATION

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BAIF DEVELOPMENT RESEARCH FOUNDATION



BAIF Development Research Foundation - formerly Bharatiya Agro-Industries Foundation - is a Voluntary Organisation established in 1967. Registered as a Public Charitable Trust, BAIF is committed to sustainable rural development. Its founder, noted Gandhian Late Dr. Manibhai Desai, firmly believed that development without research is not progressive and research without development is an academic exercise. Therefore, BAIF's research programme identifies and tests suitable technologies under diverse environmental and social conditions before introducing them to rural communities. The programme outreach of BAIF touches more than 2.5 million rural families in about 45,000 villages in 12 states of India. Its integrated development strategy comprises of activities for livestock development, tree-based farming, water resource management, tribal rehabilitation, women's empowerment, community health and environmental protection. Associate organisations of BAIF in help implement research and development programmes with a focus on local requirements.

The BAIF Mission

BAIF's Mission is to create opportunities of gainful self-employment for rural families, especially disadvantaged sections, ensuring sustainable livelihood, enriched environment, improved quality of life and good human values.

This is being achieved through development research, effective use of local resources, extension of appropriate technologies and upgradation of skills and capabilities with community participation. BAIF is a non-political, secular and professionally-managed organisation.

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Preface

Implementing rural development projects under economic and natural resource constraints presents a number of challenges. When BAIF began its journey in rural development forty years ago, there was a vast gap between technology available at research centres and its application at farm level. The strengthening of extension services over the years by public and private agencies in the country has narrowed this gap considerably in resource-rich regions. However, many socio-economically disadvantaged rural communities have remained untouched by advances in technologies that can enhance farm output. BAIF's programmes target these neglected communities, but transferring technologies to realise the potential of their meagre resources has not been an easy task.

Through a combination of identification, packaging and local testing of appropriate technologies, BAIF strives to upgrade production practices for small farmers. This is achieved through trials conducted on-station at its campuses and on-farm in development projects. Initially, these studies focussed primarily on disciplines of livestock, agriculture, horticulture, fodder, watershed and forestry. Integrated rural development being the overall objective of most of the projects implemented by BAIF, more and more studies are being carried out on issues related to women, community health, marketing of produce and socio-economic impact of projects.

Research at BAIF is financed through sponsorship, internal support and as a component of development projects. There are also studies for which technical or material inputs are received from collaborators for experimentation with BAIF using its resources to meet other requirements. In addition, beneficiaries in development projects commit their resources for experimentation and participate as co-investigators in most of the on-farm studies. Appreciating their valuable contributions, BAIF gratefully acknowledges the support of its sponsors and project participants for the research programme.

Although the quantum of information generated across BAIF's operational areas is huge, much of it remains as unpublished internal reports. In order to share this information with those associated with rural development, the maiden issue of BAIF's Research Highlights has been published this year.

Dr. N. G. Hegde
President, BAIF
24 August 2007

RECOGNITIONS

1. BAIF is recognised as a Research Institution by the Indian Council of Agricultural Research and the Ministry of Science and Technology, Government of India.
2. Pune University and South Gujarat University in Surat have recognised BAIF for conducting postgraduate studies and research leading to MSc, MPhil and PhD degrees.
3. The BAIF Central Research Station is recognised by the Maharashtra Animal and Fishery Sciences University in Nagpur as an institute for providing instruction and conducting research to partially meet the requirements for post-graduate studies in veterinary science and doctoral studies in genetics and breeding, reproduction, veterinary medicine, nutrition, management, veterinary extension, fisheries, biochemistry and dairy science.
4. The Sericulture Laboratory at the BAIF Central Research Station is recognised by the Pune University and Shivaji University in Kolhapur for undertaking doctoral studies.
5. The Ministry of Science and Technology of the Government of India recognised two research projects of BAIF on *Infectious Bovine Rhinotracheitis for Cattle* and *Rapid Disease Diagnostic Kits for Poultry and Cattle* among the milestones and new scientific heights in 1999.

Contributions to BAIF are exempt from Income Tax under Section 35(1)(ii).

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The BAIF logo is a symbolic representation of the Mission of BAIF in Rural Development. It is a visual portrayal of the four important natural resources - land, livestock, water and vegetation. Anna Bahu Kurveet Tadh Vratam testifies BAIF's commitment to the conservation of these precious resources and abundant crop production. The crossbred cow strategically positioned, signifies the efficient conversion of coarse fibre from straws of sorghum, millet, bajra and wheat into milk, a major source of protein in the diet of the poor rural people, without compromising on foodgrain production.

That milk is a product of the earth is symbolised by the two milk bottles embedded in the soil. The microscope reiterates the role of research in rural development. The wheel symbolises the blend of science and technology and an industrial approach towards agriculture. The petals of the lotus form a bell and are synonymous with rural prosperity.

The original name Bharatiya Agro-Industries Foundation (BAIF) reflected the need to consider agriculture and rural development as an industry, with sound management practices and motivation capable of turning the farmers into entrepreneurs to manage their resources, while generating gainful self-employment in their own environment. BAIF was renamed as BAIF Development Research Foundation to emphasise the need to blend development programmes with research and appropriate technologies, as development without research becomes outdated and research without development becomes academic.

A. Research Overview: 2001-2006

1. Livestock

Livestock development being the premier activity of BAIF, research on various aspects of cattle rearing has been carried out since the establishment of the organisation. In the initial years, research focussed on the adaptability of crossbreds of different exotic blood levels to local conditions. In order to address the constraint of fodder in the operational areas of BAIF, a strong fodder research programme emerged. Besides fodder grasses, there was focus on fodder trees, which eventually expanded into the programme on multipurpose trees. Animal nutrition and health received priority as these were major areas of concern under most small-farm conditions.

Subsequently, considering the potential of other farm animals in comprehensive rural development programmes, research on buffaloes and small ruminants were initiated. The principal objective of research during the initial years of the organisation was to address field requirements of BAIF projects. Thereafter, studies on broad scientific interest were included in the research programme. A major initiative in this regard was the genetic characterisation of native breeds with the aim to conserve them. The growth of BAIF's cattle development programme, which reached out to a large number of villages in the country through cattle development centres, provided opportunities for socio-economic studies and impact analysis. More recently, research on advanced themes like embryo transfer and molecular biology have been initiated so that the latest technologies can be made use of for the upliftment of the most disadvantaged sections of the population.

1.1 Breeds, Breeding and Reproduction

Dangi is a native cattle breed of Maharashtra and its distribution at present is restricted to Ahmednagar and Nashik districts of Maharashtra and Dangs district of Gujarat. It is adapted to the hilly terrain and heavy rainfall of the area. Genetic characterisation of this breed was done to help conserve and improve its productivity. Based on the coat colour, animals are referred to by different names by local cattle owners. Black muzzle (91%), black eyelid (91%), black hoof (94%) and black tail switch (88%) are dominant in a majority of the animals. The milk yield per day ranged from 1.71 ± 0.01 to 1.91 ± 0.04 l with an average of 1.75 ± 0.01 l. The average age at first oestrus, first mating and first calving were at 43.3 ± 0.18 months, 44.1 ± 0.22 months and 52.9 ± 0.23 months, respectively. The mean interval between calving to first conception was 295 ± 4.38 days and the mean duration of

oestrous cycle was 20.5 ± 0.07 days. The overall mean number of services per conception, calving interval and gestation length were 2.21 ± 0.03 , 593 ± 4.88 days and 275 ± 0.32 days, respectively.

Another initiative was to produce embryos from high performing purebred Dangi cows to multiply superior animals through embryo transfer and make them available for breeding. Superior Dangi cows were identified and brought to the BAIF Central Research Station at Urulikanchan near Pune (BAIF CRS) where the embryos were flushed out and transferred to recipients or frozen and stored. Super-ovulation of Dangi cows was higher with a dosage of 200 mg of follicle stimulating hormone compared to 360-380 mg. The mean super-ovulatory response and embryo recovery were higher during the rainy season than winter and summer. The mean values for super-ovulatory response, embryo recovery and viable embryo recovery in Dangi cows were 3.86 ± 0.41 , 3.81 ± 0.68 and 1.49 ± 0.39 , respectively. The response of this breed to synchronisation and super-ovulation were low probably due to its inherent character and endocrine constitution.

Out of the 546 Dangi cows physically examined for reproductive fitness, only 3.30% could qualify if the production criteria for donors are applied. It was concluded that adoption of the embryo transfer technology for breed conservation at field level would take some more time because of the need to increase farmer awareness. Frozen semen of promising young Dangi males was used to produce 269 male and 283 female calves. These female calves are raised as bull mothers and transferred to potential breeders at the village level. The bull calves produced by embryo transfer were raised as breeding bulls and their semen frozen and used later for insemination for conservation and improvement of the breed.



Calves produced by embryo transfer

In other studies on embryo transfer technology, the overall percentage of the flushed donors was the highest in crossbred (64.1) and Jersey (62.6) followed by Holstein Friesian (50.4) and Murrah buffaloes (25.5). Out of the 1867 embryos recovered, 692 were transferable. Significant differences were observed among the breeds for super-ovulation and total embryo recovery. Total and viable embryo recoveries were higher in Jersey compared to crossbred and Holstein

Friesian. The overall conception percentage increased from 24 in the first year to 32 in the fourth year and it was the highest for Holstein Friesian (39%) followed by crossbred (21%) and lowest in Jersey (19%).

Sexing of 62 embryos found 42 to be female and the remainder male. In an attempt to extend this technology to the field, 14 donors were flushed and 34 viable embryos were harvested. Conception rate was 45% for fresh embryo transfer and 24% for frozen embryo transfer.

The feasibility of embryo transfer in buffalo was examined by synchronising with two prostaglandin injections administered 11 days apart. Enucleation of mice oocytes and nuclear transfer using nucleus from cumulus cells resulted in the production of cloned embryos. Cumulus cells from neomycin resistant (neo^r) transgenic mice transferred in enucleated oocytes of non-transgenic mice did produce cloned embryos expressing neo^r gene. However, embryo transfer in 74 surrogates has not yet resulted in any live birth. Buffalo ovaries were used as a source of oocytes which were matured *in vitro* before enucleation. Absence of nuclear contents after enucleation was confirmed by Hoescht staining. Nuclear transfer using both cumulus cells as well as buffalo oviductal epithelial cells resulted in the development of cloned blastocysts. Recipient buffaloes were synchronised with hormones, but embryo transfers in 17 buffaloes have not yet resulted in any live birth.

Goats are an integral component of farming systems in Rajasthan. The extensive area of Aravalli range of hills provides ample opportunity for grazing animals. Sirohi is a goat breed found in a few districts of Rajasthan. The performance of Sirohi goats was evaluated in Bhilwara, Udaipur and Rajasamand districts of Rajasthan. Both sexes of Sirohi have small horns that are curved upward and backward. Other characteristics are the flat, leaf-like medium sized drooping ears, long neck with some goats bearing wattles and a bend or sword like curved body. The tail is medium in length and curved upward, udder small and round and teats placed laterally. The mean estimated lactation milk yield ranged from 102±2.01 to 107±2.05 kg during a period of 164±2.01 days. In general, breeding was during the summer months of May-June. Farmers generally maintain the breeding buck in their flock and change it every 3-4 years.

A survey was conducted to characterise the Deccani sheep, a small and hardy breed commonly found in the Deccan Plateau. Raised by shepherds of the Dhangar community, this breed has a thin neck, narrow chest, prominent spinal processes, flat ribs, Roman nose and drooping ears. There are seven different body colour combinations in Deccani sheep: black with white patches (38%), complete black (22%), white, black-brown, white-brown, black-brown-white and brown. The mean greasy fleece weight was only 496±12.17 g and the mean fibre diameter was 50.2±0.55 micron. The canary coloration was present in only 12.18% animals. The average milk yield on day 7 and day 50 of the lactation period were 263±4.32 ml and

133±2.67 ml, respectively, and the birth weight was 2.75±0.03 kg. The oestrous cycle duration and oestrous duration averaged 20.6±0.04 days and 27.4±0.24 hrs. The average age at first oestrous, age of first mating, age at first lambing, interval from lambing to first conception, lambing interval and gestation period were 10.7±0.05 months, 11.9±0.07 months, 15.7±0.04 months, 161±0.91 days, 288±1.06 days and 151±0.06 days, respectively.

1.2 Health

The rapid growth of the livestock industry has resulted in increased incidence of brucellosis, which adversely affects animal production and development. The highest incidence of brucellosis is in Madhya Pradesh and West Bengal. As the situation in Maharashtra is not well documented, a study was conducted to examine the incidence of brucellosis in animals and women who manage them. Blood samples were collected from 3,525 animals and 962 human beings. Analysis of samples showed the prevalence of brucellosis to be 3.5% in animals and 1.7% in human beings. The total livestock population was 12,925 in the surveyed households, of which 36.3% was cattle, 5.8% buffalo and 57% small ruminants. Large ruminants are found in 1,328 households and about 70% of them are artificially inseminated. Abortion is a serious problem reported by 38% of the farmers. The highest abortion of 44.4% was at advanced pregnancy.

Remedial measures against helminths found in the intestinal tract of cattle and buffalo was investigated by the Manibhai Desai Technology Transfer Centre in Navsari district of Gujarat. Faecal examination showed 40% of cattle and 43% of buffalo having helminthic infection. The incidence of the problem was higher in hilly areas (45%) than in plains (34%). Female cattle and buffaloes appeared to be more susceptible than males. The severity of infection was 39% in calves below one year, 34% during 1-3 years and 41% in animals more than three years old.

1.3 Nutrition

Mother liquor and sludge are by-products of the milk processing industry. In developed countries, mother liquor is fed as a supplement to dairy cattle and pigs while sludge is used as a manure. Both of them are also used in the preparation of complete feeds. On-farm studies on lactating cattle with mother liquor-based complete feed and sludge showed an increase of 1.5 kg in average daily milk yield compared to the traditional feeding method. The average milk yield in control and experimental groups were 9.44 kg and 10.95 kg / day, respectively. The higher milk yield of the experimental group could be attributed to the presence of high levels of dry matter and lactose in this feed. The above studies show that mother

liquor and sludge can be successfully incorporated in the diet of lactating cows. Mother liquor has a low shelf life as it ferments readily. Methods to prevent its degradation have to be identified for its safe use in animal feed. In the case of sludge, long-term feeding studies have to be conducted to ascertain possible adverse effects on animals.

The feed value of sunflower head pellets was studied in lactating crossbred cows in their second or third lactation. The average body weight of the animals was in the range of 355-375 kg and the average milk yield was 6.0-7.0 l. Animals in the control group were fed on the conventional diet of concentrate and green fodder while the treated group received sunflower head feed pellets as complete sole diet for 180 days. The dry matter intake in the control and treated groups were 8.29 and 8.53 kg/day/animal. Digestibility of dry matter was 69% for both groups, but fibre digestibility was higher in the complete feed group (66%) compared to the control group (59%). The fat percentage was 4.5 and 4.6, respectively, for the control and experimental groups. Average milk yield (5.83 vs. 5.88 kg / day) was almost similar for both groups. The cost of production of Rs. 4.70/kg of sunflower head based complete feed is also favourable. Hence it can be used as roughage for lactating cattle to reduce the feed cost.



Feed formulated with local ingredients

Intake and nutrient utilisation patterns of complete feed formulated with forest grass were examined in the form of block and mash by feeding adult cows of Holstein Friesian and Jersey breeds. The average dry matter intake over a period of 45 days in block and mash forms was 13.0 kg/day and 12.8 kg/day, respectively. The digestibility coefficients for organic matter were 71.4% in mash form as against 67.3% in block form whereas the digestibility coefficients for crude fibre and nitrogen free extract were more or less same in both groups. The crude protein digestibility and neutral detergent fibre digestibility (NDFD) were higher in the mash compared to block. Volatile fatty acid and ammonical nitrogen levels were studied by feeding the two formulations to fistulated animals and the parameters studied were almost the same with both diets.

Pearl millet straw is used as fodder by dry land farmers. Because of its low nutritive value, *in vitro* digestibility studies were conducted to determine the optimum level and type of supplements to improve the NDFD. The increase in NDFD of pearl millet straw was significantly higher when supplemented with cotton seed cake and soybean meal. But digestibility was reduced by rice bran,

sunflower meal and kokam cake. Digestibility also improved with the supplementation of cowpea, guinea grass, subabul and lucerne.

Small ruminants are an essential component of rainfed farming systems in semi-arid India. In order to promote sheep rearing as a source of income and self employment, two models were tried in clusters of 2-3 villages in Mahabubnagar and Anantapur districts of Andhra Pradesh and Tumkur district of Karnataka. The lamb fattening model, consisting of three lambs as a unit, was adopted in Anantapur district while the breed improvement model with 4-5 sheep in each unit was tried in the other two locations. Results showed that the performance of the sheep breeding unit was better in Mahabubnagar than in Tumkur and the sheep were sold early in both clusters. In Tumkur, almost all the sheep were sold in the local market whereas the sale was within the village itself in Mahabubnagar. The fattening model was successful with a gross profit of Rs. 628-922 / lamb. It was found that lamb fattening and breeding are potential activities for the study areas.

2. Agriculture, Horticulture, Sericulture and Forestry

Small farm conditions in India are such that a judicious mixture of agriculture, horticulture and forestry species has a greater chance of success than systems having single components. The tree-based farming system, popularised by BAIF as the wadi programme, has plant species that are categorised under the above three components. BAIF has been conducting applied research on many aspects of crop and tree production. Recognising the benefits of on-farm research in technology validation and dissemination, trials are also conducted in collaboration with farmers on their fields. Conducting on-farm trials presents challenges that conventional researchers seldom encounter. Hence, it requires a balance that understands the limitations of using small farms for experimentation while ensuring satisfactory research methodology and precision of information collected.

Sericulture has the potential to be a successful enterprise in several project locations of BAIF. As this is a shift away from traditional high input sericulture, technology standardisation is required on many aspects of mulberry and silkworm production. Therefore, research has been conducted to examine the effects of intercropping, varietal / species differences, biofertiliser / compost use and methods of leaf harvesting. The studies on silkworms were on the influence of rearing techniques, seasonal differences, protection against diseases, growth stimulation and waste utilisation. Studies were also conducted on tasar silk production and extension approaches for the promotion of sericulture.

2.1 Crop production

2.1.1 Fodder production

Rearing crossbred cows and buffaloes is emerging as a major occupation of farmers in Western Maharashtra, but only 3% of the required fodder is produced by them. As off-farm sources are dwindling, fodder crops have to be included in the cropping pattern. Therefore, trials were conducted to identify suitable cropping patterns that can produce fodder rich in protein. Patterns with cereals and legumes in several combinations were investigated at BAIF CRS. Maize, sorghum, pearl millet and cowpea were harvested at the 50% flowering stage with a single cut whereas berseem was harvested thrice at 55-60 days after sowing and subsequently at 22-25 day intervals. Pooled data of five years indicated that the cropping pattern with berseem in rabi, sorghum in summer and maize in kharif produced the highest maize fodder equivalent yield (73.2 t/ha), which resulted in the highest gross monetary returns (Rs.121,855/ha/year). The soil fertility status was also improved by this cropping pattern.

2.1.2 Compost making

Low soil organic matter content adversely affects soil fertility in dry land soils. Sustained application of organic manure can partly overcome this problem, but its availability is low. Farmers in many countries have successfully used the technology of Effective Microorganisms (EM) for biomass recycling. Experiments were conducted at BAIF CRS to study the potential of compost made with EM.

Soybean husk was composted with EM solution as the microbial enhancer. The application rates were 2.0 t/ha for both EM compost and farmyard manure on a low organic matter gravelly soil. At these rates, both compost and farmyard manure were inadequate to increase the yields of onion and soybean in the first and second seasons of application. During subsequent years, however, favourable effects of EM compost on crop yields were apparent and it continued into the next season. This shows that even relatively small quantities of organic matter enhance crop production if fortified with microorganisms and applied at regular intervals.



A trial with different composts

In another study, composting of sugarcane waste and wheat straw were studied with different decomposers and the quality of the compost was tested on onion and

beet root. The promising decomposers were EM, earthworms and VSI culture. Sugarcane waste decomposed faster than wheat straw. The composts were applied at the rate of 10 t/ha and beet root was grown. This was followed by onion during the next season on residual fertility. Beet root yields with composts made with EM and VSI culture (15.6 t/ha) were significantly higher than in the control (10.8 t/ha). However, the plots that produced higher beet root yields had lower onion yields in the following season. This inverse relationship was probably due to the faster release of nutrients from the sugarcane waste compost. Mixing sugarcane waste and wheat straw in 1:1 ratio and supplementing with decomposing microbial cultures and / or earthworms can help improve crop yields.

2.1.3 Jatropha cultivation

A topic of current interest is the use of oil from tree-borne oilseed species (TBOS) for biodiesel production. Among the TBOS, jatropha has the potential for small farm agroforestry. Experiments were conducted at the BAIF campus in Karnataka to ascertain the yield response of jatropha genotypes grown under different plant densities and agroforestry arrangements. The study showed pronounced differences among genotypes in their growth and yield. The local genotype from Karnataka was more adapted to the site and produced more seed than the genotypes from Maharashtra and Nicaragua. Increasing the jatropha plant density beyond 2,000 plants / ha tended to reduce the seed yield. Jatropha plants produced some seeds in the second and third year, but a harvestable seed yield was obtained only in the fourth year. The highest seed yield obtained in the study was about 500 kg / ha in the fifth year. The study also found jatropha to be a suitable species for agroforestry as it did not compete with the intercrops during the period of experimentation.

2.1.4 Phosphate solubilisation

The use of microbial inoculants to mobilise phosphorus that remains fixed in the soil is a proven technology. The effectiveness of a phosphate solubilising concentrated liquid inoculant on paddy crop was examined in Navsari district of Gujarat. Roots of paddy seedlings were dipped in the inoculant solution (100 ml in 10 l) for 10 minutes and then transplanted by farmers on their fields. The response to this treatment was positive and the mean increase in paddy yield in the treated plots was 18% more than the control. This study shows that the efficiency of utilisation of applied phosphorus can be increased by the use of microbial inoculant.

2.1.5 Waste recycling

Economic development is associated with the generation of enormous quantities of solid waste. Fly ash produced by thermal power stations and sludge in city sewage are solid wastes that have to be managed and disposed off continuously. Both fly ash and sludge contain crop nutrients. Experiments were conducted for four seasons at BAIF CRS to study the effect of recurring applications of flyash and sewage sludge on the growth and yield of French bean, soybean and radish. The application rate was 52 t/ha, which was applied as fly ash, sludge or a mixture having equal quantities of both. These treatments were compared with the control and that receiving recommended fertilisers. A mixture of flyash and sludge increased the yield of French bean and soybean by 53% and 30%, respectively, over the control treatment that received NPK fertilisers at recommended rates. Radish grown with the application of only sludge yielded 24% and 80% more than the control during the two seasons of its cultivation. Unlike sewage sludge or the flyash-sludge mixture, the application of only flyash did not sustain crop yields.

The effect of dairy sludge on growth, yield, fodder quality and chemical composition of soil was investigated at BAIF CRS. Sludge application significantly improved crop performance. Follow up studies are required on yield stability with sustained use, determination of applicable rates for different crops and long term effects on soil properties. In another study, two herbal products were assessed for their influence on growth, yield, disease and pest control of cucumber. A product named Praghat was effective in the control of leaf minor and thrips while another product, Amogh, was effective against caterpillars.

2.1.6 Extension

Agricultural extension services in India are provided by government agencies, research institutions, grower cooperatives and non-government organisations (NGOs). A crucial role is played by NGOs in achieving food sufficiency through agricultural extension support to farmers in remote areas. Technology transfer is effected through different formations of farmers. For example, farmers' clubs in Bharuch district of Gujarat facilitate agricultural extension. A study of the clubs showed that a majority of the members were middle aged, had primary to secondary level of education and large size of landholding. The respondents felt that the clubs addressed their needs while planning the agricultural programme. Farmers' clubs motivated the members to take action that resulted in speedy adoption of latest agricultural technologies. They acted as pioneers in providing information on new strategies of agriculture and explained complicated topics in simple language that helped improve the practices adopted by farmers.

2.2 Sericulture

2.2.1 Mulberry

The inter-row space in mulberry plantations can be made use of for growing intercrops. The suitability of species for intercropping was studied in one and two-year old mulberry rows that were 6.0 m apart. The spacing for mulberry within the row was 2.0 m and the trees were lopped at 50 cm height. Short-duration vegetables maturing in about 45 days were tried as intercrops. Intercrop yield (6,700 kg of biomass in 0.2 ha) and cost : benefit ratio (1:2.6) were the highest in coriander and radish, respectively. Crops like beans and ladies finger that require frequent crop protection measures are unsuitable as intercrops because the chemical sprays can contaminate mulberry leaves and affect the silkworms. Growth and yield of intercrops were unaffected during the first two years of mulberry growth. In on-farm trials, mulberry varieties S-1635 and S-36 produced 1.5 times more leaf yield than the widely grown K-2 variety in intercropped fields.

Labour-saving tools for harvesting can increase the profitability of sericulture as the present method of using sickles is laborious. A study to compare the available implements found the hand-held mower to be more efficient than two other mechanised tools and the manual method. Whereas the manual method required 37.5 persons to harvest the shoots of a well-established mulberry plantation of one ha, the same task can be completed by five persons with the mower. Another benefit is the evenness in cutting the shoots, which helps in the regrowth. The cost of the mower can deter its use, but this can be overcome by farmers buying it as a group. Efforts are also underway to develop a low cost variant.

2.2.2 Silkworm

A foam pad cover for chawki rearing of silkworms was developed and tested. It is suitable for worms up to the third instar. The advantages of this pad cover are better growth of worms, uniform moulting, higher survival and suitability for summer conditions. In on-farm studies in Western Maharashtra, locally developed silkworm races WBC-1, WCS-42 and GWA-1 showed better performance than PM and NB₄D₂. Nuclear polyhedrosis is a serious disease of silkworms at high temperatures and cannot be controlled easily once the infection occurs. Therefore, an experiment was conducted to test the efficacy of bed disinfectants in preventing the disease incidence. Alternate day application of a preparation named *Resham Kit Oushadha* and formalin chaff was more effective than other treatments in preventing the disease and improving larval and cocoon quality. Preliminary studies were conducted to investigate the impact of pyramid structure on pre- and post-cocoon parameters of

silkworm. The pyramid built with cardboard and aligned in the north-south axis created a magnetic field. Silkworms in their fourth instar were kept inside the pyramid until pupation. Results showed increase in larval weight, cocoon weight, shell weight, filament length and filament weight. Further studies on this aspect are required.



Surface view of the chawki cover

Erisilkworm (*Samia cynthia ricini*) is a potential species for silk production if suitable feed material is available. Although it feeds primarily on castor leaf, this worm is polyphagous in nature and accepts leaf of species such as tapioca. The suitability of jatropha leaf as a feed for erisilkworm was examined at BAIF's Karnataka campus. Worms fed on jatropha leaf had very high mortality and those surviving also showed very poor growth and vigour. Mixing jatropha leaf with that of castor in equal proportions showed improved survival and growth, but jatropha does not appear to be a feed for erisilkworms.

2.2.3 Waste utilisation

Organic matter availability for composting is generally low in rural areas. Therefore, silkworm waste can also be used together with cow dung and farm waste in compost preparations. Compost of silkworm waste was compared with urea and cow dung compost as sources of nutrients for wheat intercropped in mulberry plantations. The highest grain yield of wheat was in the plot receiving urea and this was followed by silkworm compost. Several soil and grain quality parameters were found to be high with the application of silkworm compost.

2.3 Forestry

Natural stands of vetiver grass (*Vetiveria zizanioides*) have been fast depleting because of the indiscriminate exploitation. Organised cultivation of this species is necessary to realise its well known benefits of preventing soil erosion and runoff losses, besides meeting the commercial uses. Therefore, the effect of organic manure (2.0 t/ha) or chemical fertiliser (80:40:30 kg/ha NPK) on root yield of vetiver with and without shoot pruning was investigated. Pruning was done at three month intervals in the designated treatments. The highest root yield was obtained with the application of vermicompost without pruning. Because pruning adversely affected growth of vetiver, the treatment in which the shoot was not pruned produced almost 40% more root dry matter than the pruned treatment. The dry matter content of roots increased from 35-40% at six months to more than 80% in 12 months after planting.

Agave (Agave sisalana) is a hardy species that thrives on denuded wastelands and high temperature conditions. It is useful for live fencing and the leaf fibre has economic value. Propagation of agave is usually by suckers or bulbils and a plant produces only 8-20 suckers and 250-1,800 bulbils in its lifetime of around 20 years. Therefore, mass multiplication of agave was attempted with bulbil sections. The method involved splitting the bulbil into two or four vertical sections or single basal leaf with sheath. The sections were dipped into 0.1% bavistin for two to three minutes and their base was smeared with indole butyric acid (IBA) powder. The IBA concentrations used were 1250, 2500 and 5000 ppm. The treated bulbil sections were planted in polythene bags and the rooting response was examined 45 days after planting. Splitting the bulbils into four and treating with IBA at 2500 ppm was the best method for multiplication of agave.

Among the nursery practices of forestry species investigated at BAIF's research facilities at Lakkihalli in Karnataka is the rooting of cuttings of *Prosopis alba*, a thornless substitute for *Prosopis juliflora*. Terminal cuttings treated with a combination of 3000 ppm of IBA and 1300 ppm of Kinetin resulted in 43% rooting in hydropit. This pit of 1.0 x 0.3 x 3.0 m was covered with a transparent polythene sheet. It simulated mist chamber conditions and was a low-cost alternative for the propagation of forestry species. In another study, raising seedlings of *Cycas circinalis*, an endangered species, was studied as suckers of this species are not easily available. Germination of 85% was possible on beds that were raised 15 cm above ground level.

India has a rich diversity of bamboo species, but the populations of many of them have been declining in recent times. Therefore, a germplasm collection of bamboo was established at BAIF CRS. It comprises of 24 entries belonging to five genera and 13 species. Observations showed *Bambusa arundinacea*, *Dendrocalamus brandisi* and *Dendrocalamus strictus* to be more suitable than others for semiarid areas of Maharashtra. Growth of most bamboos almost doubled on shallow gravel soils.

3. Water Resource Development

Several innovative approaches for the harvest and efficient use of water have been explored because water availability is the major resource constraint in BAIF's operational areas. The focus areas in this regard include technical aspects as well as community mobilisation efforts. A field level innovation that was successfully introduced for harnessing water was the parallel positioning of farm ponds to maximise water retention on a slope in Hassan district of Karnataka. This farm pond network increased the water availability and thereby changed the ecological conditions of the watershed and the socio-economic status of the people. This operational scale intervention is replicated elsewhere by other agencies as well.

Research is conducted in ongoing and completed watershed development projects and the findings are used to strengthen the overall programme. The impact of watershed development on livestock, livelihood and quality of life of the people was investigated in Uttar Pradesh, Rajasthan and Karnataka. Another study on the integration of drinking water supply, sanitation and watershed development in seven micro-watersheds in five states of India has given a deep insight into the water-related issues of rural communities. Other important studies include the effect of domestic waste-water use on agriculture and people in Uttar Pradesh, effect of rainwater harvesting on the water quality in Gujarat and group irrigation systems in five states. The research-oriented approach has improved the programme and made it holistic.

In Bundi district of Rajasthan, remote sensing and field data were integrated into a geographical information system in the preparation of monitors. Similarly, sustainability indicators have been developed and their utility tested for watershed management. These can be used by committees that manage the watersheds in the post-implementation phase. Organisation of watershed management committees with built in mechanisms for equitable sharing of water and group wells for small landholders are other initiatives that can be adopted on a larger scale. The integrated land and water resource based watershed programme with silvipasture in Rajasthan, ravine land reclamation in Uttar Pradesh, farm pond network in Karnataka, use of ferro-cement in water resource development are some of the key innovations in the programme gaining wide replicability.

4. Social Outreach and Community Health

Transfer of technology alone cannot ensure rural development. Reaching out to people to understand their technical requirements and mobilising them for community action are essential ingredients for any development programme. The integrated nature of BAIF's projects provides ample opportunities for research on various aspects related to community outreach. A community mobilisation effort that also has a bearing on women's empowerment is the formation of Self Help Groups (SHGs). Studies on sociological aspects of SHGs with particular emphasis on their structure and function have been conducted in several project locations of BAIF. Assessment of extension requirements is a research area that is likely to receive greater focus in time to come.



SHG members selling bangles

A preliminary study was conducted to understand the perceptions of women about their participation in SHGs. It was found that women joined SHGs not solely for money matters, but for other purposes such as exchange of information and to engage in income generation activities as well. Activities for SHGs have to be redesigned periodically to suit the changing needs of members. Gathering together as a group is the focal point of SHG functioning and its agenda changes depending upon the age of the group. As the credit needs of the members change with the age of a SHG, creating a corpus at the federation level is useful. Participation in SHG activities improves the decision making ability of members at family and community levels.

An insurance scheme for SHG members in Pune district identified death and hospitalisation as the main reasons for opting for cover. After the initial enrolment, renewal for the scheme declined over the next three years. Therefore, a survey of 264 randomly-selected women of 88 SHGs was conducted to determine the reasons for non-participation. The important reasons ascribed by 38-44% of the respondents were not being present when the topic was discussed, did not know what is insurance, did not have the money for premium payment, the closing date was over before deciding, and wanted to see the benefits that accrue to others before taking a decision. It is evident that SHG participants have to be familiarised with all aspects of insurance to encourage their participation.

A series of studies that dealt with the inter-dependence between environment and human health was conducted and the findings provide interesting insights into prevailing practices. In Chitrakoot district of Uttar Pradesh, there was discrimination in favour of boys in the distribution of available food. Moreover, the intake of nutritious food items like pulses and vegetables was insufficient among tribal communities. Lack of iron and vitamins in the diet affected the health of pregnant and lactating women. Fasting, early marriage, early and closely spaced pregnancies and lactation are the reasons for the poor health of women. In tribal areas of Gujarat, knowledge about indigenous crops and food preparations is on the decline among young women. Change in belief, cropping pattern and land use practices are also reasons for changing food habits. Low water quality and strenuous work combined with malnutrition adversely affected haemoglobin content and general health of women in Thane district of Maharashtra. In Vidisha district of Madhya Pradesh improvement in the economic status of the family did not reflect in enhanced nutrition and health of women.

A constraint often encountered by small farmers is the unavailability of credit for inputs. Loans available from SHGs for its members have emerged as a reliable source. This was confirmed in a study of SHGs in Nashik district of Maharashtra that are more

than five years old. Demand for credit was more in irrigated areas and the availability of credit resulted in the increase in the cropping area. Another observation was the change in cropping pattern from staple food crops to cash crops. In general, standard of living, sense of well-being and happiness increased among members of SHGs. Similarly, 41% of SHG members who participated in a project in Baran district of Rajasthan availed bank loan and 63% availed internal loan. Current annual average family earning is about Rs. 25,000, which is an increase of 73% over the pre-project income of the participants. Several other activities and fund management have been taken up by members through their groups and the overall outcome is the increase in income of households and improved status of natural resources.

B. Research Highlights: 2006-2007

1. Livestock

1.1 Ex-Situ Conservation of Jaffarabadi Buffalo and Krishna Valley Cattle

S. B. Gokhale and R. L. Bhagat

The conservation of animal genetic resources has become an issue of importance all over the world. Different breeds of livestock were evolved through selection since ancient times to meet human needs. Unfortunately, there has been serious erosion in germplasm resources of domesticated animals during the last century. It is globally accepted that livestock breeds should be considered a heritage and accorded protection and conservation. Although live animal conservation has many advantages like improvement of the breed over time and purification of breed from unwanted traits, it is very expensive because of the number of animals to be maintained. Alternatively, cattle and buffalo germplasm can be conserved in the form of semen and embryos with the use of modern tools of biotechnology.

National Bureau of Animal Genetic Resources (NBAGR) sponsored a project for the germplasm conservation of Jaffarabadi buffalo and a similar project for Krishna Valley cattle. The main objective of both projects was to conserve germplasm of elite / unique animals of the designated breeds in the form of frozen semen. It envisaged procuring twenty unrelated young male progeny of elite animals from the breeding tract of each breed and maintaining them for one year. These males are to be trained to donate semen. At the rate of 2,000 semen doses, the 15 males will produce 30,000 doses, which will be cryo-preserved and handed over to NBAGR for their gene bank. The male progeny of elite mothers will be extensively used for breed improvement in their respective tracts.

The native tract of Jaffarabadi buffaloes is the districts of Junagadh, Amreli, Bhavnagar and Rajkot in Gujarat. Based on breed information on physical

characteristics, bull calves were identified and information on address of owners, age of animal, dam and sire and willingness to sell the animal was collected. Selected bull calves were screened for contagious diseases like brucellosis, tuberculosis and John's disease and 13 calves were purchased for conservation. Their physical measurements like chest girth, body length, weight and height at withers are recorded monthly. Average weight of these bull calves at 20 months was 320 ± 7.26 kg while the means for chest girth, body length and height at withers were 166 ± 1.29 , 127 ± 0.96 and 123 ± 1.14 cm, respectively. Preventive vaccination of these bull calves against contagious diseases is done at regular intervals. Some bull calves have attained the reproductive stage and will be trained for semen donation after verifying body weight and age. Another seven bull calves have been identified and health tests are in progress.

The original home tract of Krishna Valley cattle, according to literature, was Sangli and Satara districts of Maharashtra and Belgaum, Bijapur, Bagalkot and Dharwad districts of Karnataka. There were 650,000 animals of the breed in this tract in 1946, but it is no longer found in the Maharashtra locations. Pure Krishna Valley cattle is found at present only in Jamakandi, Mudhol and Athani Talukas of Karnataka where it is known as Kadi Kannu, which refers to their black eyes. At present, there may not be more than 1,000 true-to-type animals. Many families owned 8-10 animals 10 years back, but it is down to 1-2 at present. A majority of the farmers who own this breed are small farmers who cannot afford to purchase and maintain larger animals like Amritmahal, Khillar and Hallikar.

Based on available information, a note containing comparative characteristics and photographs of Krishna Valley, Amritmahal, Khillar and Hallikar breeds was prepared and a training conducted for those who would be scouting the tract for the breed. After screening 150 villages, about 170 animals were identified. They included breeding bulls, bullocks, lactating cows, heifers and calves of different ages. A list of farmers owning Krishna Valley breeding bull calves of 1-4 years was prepared and all the bull calves were physically seen and verified. They were tested and found to be negative for diseases such as brucellosis, tuberculosis and John's disease. After completing the necessary Government formalities, seven bull calves were purchased in 2005 and another in 2006. Physical measurements like chest girth, body length, weight and height at withers of these bull calves are measured monthly. The average body weight of these calves was 277 ± 7.23 kg; mean measurements of chest girth, body length and height at withers were 153 ± 1.18 , 122 ± 1.50 and 124 ± 1.33 cm, respectively. Preventive vaccination of these bull calves against contagious diseases is done regularly. Once they reach the required body weight standards, semen collection will be initiated.

1.2 Evaluation and Characterisation of Khillar Cattle

S. B. Gokhale and R. L. Bhagat

Indigenous cattle breeds have beneficial traits such as draught power capacity, heat tolerance, disease resistance and adaptability to harsh agro-climatic conditions. Khillar is a breed native to the Western Maharashtra districts of Sangli, Solapur and Satara. Studies on Khillar, believed to be a distant relative of Hallikar breed of Karnataka, are limited. Therefore, research was undertaken with the objectives of studying the demographic and geographic distribution, population status, management and socio-economic use of this breed. The technical programme envisages the recording of physical growth, reproductive traits, feeding and management practices of 3,000 animals consisting of calves up to one year, young stock of 1-3 years and adults of more than three years (milking females, working males and breeding bulls). The study covered 60 randomly selected villages spread over 12 blocks in the districts of Sangli, Satara and Solapur.

Table 1. Reproduction and production performance of Khillar animals.

Parameters		Values
Female	Age at first oestrus (months)	36.9±0.13
	Age at first calving (months)	49.4±0.13
	Calving Interval (days)	505.6±1.00
	Gestation Length (days)	279.2±0.10
	Life time lactations	6.7±0.05
	Average milk / day (litres)	2.4±0.02
	Average lactation length (days)	189.3±0.88
	Total lactation milk yield (litres)	451.5±4.73
Male	Age at first mounting (months)	24.3±0.12
	Age at first mating (months)	28.5±0.21

In the districts surveyed, 43% of the large ruminants were Khillar cattle. It was found that 48% of the farmers maintained Khillar animals for agricultural operations and milk for home consumption. Nearly 90% of the respondents were engaged in agriculture followed by 6% as agriculture labourers and the remainder operated small businesses like grocery shop, eating house and flour mill. About 75% of the animals had proper housing, the average grazing distance was 2.38±0.03 km and average period of grazing was 7.21±0.01 hours in a day. Almost all the farmers fed the animals on concentrates like oil cakes or crushed grains. Qualitative observations on appearance showed two variants of Khillar. Animals with black-coloured horn,

eyelid, eyeball, muzzle, tail-switch and hooves are locally called Kajalya and those having these parts in carrot colour are called Gajarya.

1.3 Progeny Testing Programme of Murrah Buffalo in Uttar Pradesh

L. Sharma and R. R. Singh

Buffalo milk production, an important traditional occupation in many parts of the country, is a major source of income for many households. In recognition of the need to improve the productivity of buffaloes, the scope of work to be undertaken has been emphasised in the National Project on Cattle and Buffalo Breeding. Considering the low productivity of buffaloes in Eastern and Central Uttar Pradesh and the scope for their improvement, a project for their genetic improvement through progeny testing of bulls was initiated in 10 districts of Uttar Pradesh in 2006. The objectives of the study are to select superior Murrah buffalo bulls and provide their germplasm for improving milk yield.

The methodology involved the selection of at least 10 bulls and supply of their semen for two consecutive years. At least 2,000 doses of semen will be frozen for each bull introduced in the programme. The semen doses are allotted randomly in the area. The target is to record the performance of at least 40 daughters to evaluate each bull. Frozen semen of progeny-tested bulls will be used on a large scale for the genetic improvement of buffaloes in the next generation. Elite bulls in the upper 20% will be used for breeding. The male progeny of these bulls will be retained for breeding during the next generation. The traits measured are growth (body length and chest girth at birth, and 12 and 18 months after), reproduction (age at first conception and first calving, number of services for first conception) and production (first lactation milk yield).

Out of the 9,283 inseminations carried out, 2,092 pregnancies were confirmed in 5,310 cases. Pregnancy diagnosis for the remaining inseminations is underway. Among the animals tested, 41.3% was confirmed pregnant, 27.2% empty, 8.7% repeat and 16.4% not examined (may be due to buffaloes not being present in the herd or delay in pregnancy diagnosis follow up). The results of this programme will help identify elite Murrah germplasm for continuous genetic improvement in the buffalo population on a regional basis in the country. It would also result in a number of indirect benefits like simple record keeping by herd owners showing sale or purchase of animals, critical information on management systems followed and comparative performance of animals.

1.4 Genetic Characterisation and Reproduction of Ongole and Gir Cattle

A. B. Pande

Ongole and Gir are promising cattle breeds of India, but their genetic diversity has not been adequately studied. Studies in relation to biotechnological interventions such as embryo transfer can help assess and exploit the full potential of this breed. Therefore, research was conducted with the overall objective of conserving the genetic variability of Ongole and Gir breeds. Individual studies examined embryo yield of donor cows, the potential of increasing the number of viable embryos and the semen behaviour of bulls. A total of 47 Ongole donors and five bulls were selected for the study. Each cow was fed 20-25 kg chaffed green fodder, 4.0-5.0 kg lucerne and 1.0-1.5 kg concentrate / day during the super-ovulation treatment.

On the basis of gynaecological examination, cyclical and health status, donor cows were conditioned for synchronisation with progesterone implant. Subsequently, they were subjected to super-ovulation treatment with follicle stimulating hormone injection for four consecutive days in tapering doses ranging from 100 to 300 mg. The BAIF mobile embryo transfer laboratory was used for embryo searching, evaluation and freezing. The batch-wise planning of donors, super-ovulatory response and embryo recovery are presented in Table 2. The mean super-ovulatory response, viable and total embryo recovery were 8.56, 3.75 and 9.00, respectively. The technical programme requires the selection of 10 bulls for semen freezing during the first year, but only five old, weak bulls were available. Therefore, only 8.75% ejaculates could be frozen and 4,249 doses produced. This was lower than the mean output from other bulls during the period.

Table 2. Number of donors planned, super-ovulatory response and embryo recovery in Ongole breed.

Batch	Number of donors planned	Number of donors flushed	Super-ovulatory response		Embryo recovery	
			*CL	**GF	Viable	Total
Batch I	12	12	90	15	32	86
Batch II	36	32	190	24	98	201
Batch III	41	38	301	31	130	275
Batch IV	43	40	223	48	126	267
Batch V	42	39	240	37	71	269
Overall	174	161	1044	155	457	1098

*Corpus Leutium **Graffian Follicle

1.5 Field Progeny Testing of Holstein Friesian Crossbred Bulls

S. B. Gokhale and R. L. Bhagat

Holstein Friesian (HF) is extensively used for cross breeding of cattle. A very high blood level of this breed can lead to deterioration in the performance due to poor adaptation to feeding regimes, unsatisfactory management practices and unsuitable climatic conditions. It is necessary to use genetically superior crossbred bulls in breeding programmes. In this context, the selection of breeding bulls on the basis of their performance of female progeny is essential to maintain and improve milk production. Therefore, an ad-hoc research scheme was initiated by the Indian Council of Agricultural Research in 1985 for progeny testing of crossbred bulls under village conditions. Following the establishment of the Project Directorate on Cattle, this research became a coordinated network project with necessary modifications in the technical programme.

This program envisages testing of 30 HF crossbred bulls in each batch having 50-75% exotic inheritance with the dam's minimum milk yield of 4,500 kg. The project is implemented in three geographically distinct locations: by BAIF in Maharashtra, Punjab Agricultural University in Punjab and Kerala Agricultural University in Kerala. The target is to record at least 40 daughters / bull spread over these three areas. Information on animal insemination, pregnancy result, date of calving, data on milk production and loss with reasons were recorded. Data was also collected on farmer's socio-economic status, herd size, land holding, feeding and housing of animals. Milk yield of crossbred animals was recorded at fortnightly intervals. The first record was taken within 15 days of calving and the lactation yield was calculated using the test interval method.

Under this programme, 1,480 farmers have been identified in Ahmednagar, Pune and Satara districts of Western Maharashtra. The average herd size in the project area was 6.04 and 89% of them were HF crossbred, followed by 9.6% Jersey crossbred and 1.1% non-descript animals. It was noticed that 56% of the animals were in milking and 44% were heifers. Among the milking animals, 35.5% were in their 1st to 3rd lactations, 18.2% in 4th to 6th lactations and 1.7% were in the 7th or higher lactation. The batch of 25 bulls introduced for test inseminations comprised of 15 bulls from BAIF and five each from Meerut and Ludhiana.

During the period of 18 months, a total of 6,806 inseminations were performed. Out of these, 6,508 were followed up and 2,917 pregnancies were confirmed. The average conception rate of this batch was 44.8%. Out of the 25 sires under study, 13 recorded conception rates of more than 45%, seven had rates in the range of 40-45% and the

remaining sires recorded rates between 37-40%. During this period, 983 births were recorded and 45.3% of them were females. Out of the 416 inseminations performed in the next batch, 88 pregnancies were confirmed. The cumulative conception rate in this batch was 44%. During the reporting period, 3,991 inseminations were carried out and 1,596 pregnancies confirmed. The average age at first calving and average lactation milk yield for batch II progenies were 34.9 ± 0.53 months and $3,001 \pm 80$ kg, it was 35.5 ± 0.93 and $3,025 \pm 119$ kg for batch III progenies and 32.1 ± 1.52 months and $2,956 \pm 157$ kg for batch IV.

1.6 Gir Cattle and Jaffarabadi Buffalo Improvement in Gujarat

S. B. Gokhale

Indiscriminate crossbreeding without proper assessment of the genetic potential of promising local breeds may result in loss of diversity and adaptability if selection is based on high milk production alone. Gir cattle and Jaffarabadi buffalo are native to the Saurashtra region of Gujarat. The number of purebred Gir cattle, a promising dairy breed of India, has been declining with a corresponding increase in crossbred animals. Similarly, Jaffarabadi is a buffalo breed known for high milk production and fat percentage. Research on these two breeds was initiated to improve their production and productivity. Breeders associations were also formed to continue the breed improvement work and an information system to monitor the performance of individual animals and breeding services was evolved. The number of inseminations carried out under the project is 17,433 in Gir cattle and 31,217 in Jaffarabadi buffaloes. This resulted in the birth of 3,383 Gir (1,512 male and 1,571 female) and 4,839 Jaffarabadi (2,664 male and 2,175 female) calves.

1.7 Dynamics of Livestock Development in Gujarat

B. R. Patil

Mixed production systems having crop and livestock components are dominant in many developing countries, including India. Dairy farming in such systems can increase household income and contribute to poverty alleviation. Variable success in the transfer of dairy technology has clearly shown that adoption is context-specific, related to the physical and socio-economic environment, access of farmers to resources, access to information and personal attitudes. These considerations were incorporated in a series of concepts and methods to replace narrow technology-driven approaches with broader ones such as Farming Systems Research (FSR). BAIF's livestock development experiences in Gujarat were analysed with the use of FSR methodology.

Total livestock population, comprising of defined and undefined breeds, increased annually by more than 1% in the last four decades, with buffalo and goat populations increasing faster than cattle. Analysis and modelling indicated limited genetic potential of local breeds and shortage of feed resources, both quantitatively and qualitatively, as major constraints to livestock development. Crossbreeding for breed improvement and use of improved local feed resources were identified as suitable technologies to alleviate these constraints. Ex-post performance monitoring of some BAIF crossbreeding programmes show that crossbred cattle fitted well in the smallholder mixed farming systems of both tribal and non-tribal farmers in all three selected agro-ecological zones taken for the study. Milk production of crossbreds was substantially higher, as was livestock gross margin and household income. Although quality of the roughages is a major factor, farmers owning crossbreds tried to adjust to the needs of the cows by feeding concentrates. There was no difference in the workload and division of labour between households with and without crossbreds. Crossbreeding thus proved a techno-economically and socially viable livelihood option for both mixed and landless farming systems.

Various modelling approaches were used to examine the suitability of feeding technologies such as urea supplementation, use of local and commercial concentrates, urea-treated straw with concentrates, and leuceana tree leaves for crop-livestock systems. Major conclusions were that (i) concentrate feeding is beneficial to farmers with market access and crossbred cows, (ii) crossbreeding is more remunerative for landless and tribal farmers than for non-tribal farmers while feeding interventions are more effective for crossbreds than for local cows, (iii) highest farm income is achieved at medium level of milk yields / animal because high milk yields require the use of quality feed, which renders straw losing its value as feed; this would result in the cropping pattern shifting from grain crops to cotton.



Cross-bred cows in a rural household

During a period of about 30 years, three phases in on-field testing can be distinguished in BAIF's livestock programme: the initial period of predominantly top-down approaches, the second phase with emphasis on participatory identification and testing of technologies, and the third phase with work at community and watershed level. The study showed that adoption of technologies is facilitated when it involves local feed

resources that are readily available and requires only small changes in farm practices. The dynamics in approaches involves the comparison of top-down, objectivist and

reductionist approaches on the one hand and bottom-up, constructivist, holistic and self-organised approaches on the other. A number of crosscutting issues such as the notion of real versus perceived problems, hierarchy and grid, phases in development and aspects of holism versus reductionism have to be analysed in understanding the processes. In conclusion, development is a continuous process in which goals change over time and space. If development is indeed a dynamic process, it implies that choice of methodology and technology should go along with changes occurring in that process. Agricultural research and development behaves as a complex adaptive system with its own dynamics and associated paradigm shifts. Because it is a complex adaptive system, development organisations such as BAIF have to show a dynamic behaviour to deal with continuously changing situations.

2. Agriculture, Horticulture, Sericulture and Forestry

2.1 Vermiwash

S. Kale, P. Nisal, V. C. Badve and J. D. Desale

Vermiwash is the exudate collected from substrate on which there is live earthworm activity. It is a honey brown colour liquid that contains heterotropic bacteria, fungi and actinomycetes. It is also rich in enzymes, hormones, vitamins and nutrients in a readily available form. Considering its potential in crop production, the response of fodder maize to vermiwash produced with four different substrates was studied. Raw materials and final products were analysed for parameters like dry matter, crude fibre, ether extract (oil), ash, acid insoluble ash (silica), total nitrogen, organic carbon, gibberellic acid, neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and characteristics like leaf length, number of leaves, plant height, stem diameter and leaf area.

The four substrates in the study were shelled corn cobs, soya hulls, spent mushroom stacks and pearl millet straw. The earthworm species used was *Eisenia foetida*. The effect of vermiwash on seed germination was examined by dipping the seeds in the vermiwash solution for four hours before sowing; soaking the seeds for four hours in water before sowing and absolute control. Soaking of seeds in the wash obtained from the substrates of corn cobs, soya hulls and mushroom stack straw resulted in higher germination percentage of maize.

The substrates were analysed for proximate principals and organic carbon. As the chemical composition of substrates differed from each other, the composition of the vermiwash preparations was also different from each other. The wash obtained from the substrate of mushroom stacks had the highest nitrogen and organic carbon, but

did not have gibberellic acid. Vermiwash of crushed maize cob and soya hulls contained 1.2 and 1.5 mg/l of gibberellic acid, respectively. The effectiveness of vermiwash was tested on African Tall variety of maize by spraying on seedlings. The dry matter production of maize increased significantly in all the vermiwash-sprayed treatments compared to the control. Crude protein also increased in all the treatments and it was significantly higher than control in mushroom stack and pearl millet straw vermiwash treatments.

2.2 System of Rice Intensification

M. Patil, S. Bhagriya and V. C. Badve

The main monsoon crop of tribal communities of South Gujarat is rice. They follow traditional rice cultivation practices which include raising seedlings in a nursery and transplanting on puddled land. Practices such as burning of biomass placed on nursery plot and excessive water use contribute to inefficient use of resources. In this regard, a practice like the System of Rice Intensification (SRI) can be very useful as it can utilise resources more efficiently and increase rice yields. Therefore, the suitability of different varieties / hybrids of paddy cultivated in the region for SRI method of production was investigated with on-farm trials. Data was collected on number of tillers at 15-day intervals up to ear head emergence, the number of effective tillers thereafter, and grain and straw yields.

The average number of tillers / hill in SRI was less (5.5) compared to the conventional method (7.1) at 30 days after transplanting. However, at 90 days after transplanting, tiller number was greater in SRI (18.8) compared to the conventional method (14.8). The lower tiller number at 30 days in the SRI treatment was probably due to the fewer number of seedlings in each hill than the conventional treatment. The main yield determinant, number of effective tillers, was 82% in SRI and 71% in conventional method. Effective tillers were more in selections compared to hybrids and local varieties.

Average grain yield in SRI was 3,897 kg / ha whereas it was 3,047 kg / ha in the conventional method. Within SRI, the highest yield was obtained in hybrid (4,628 kg / ha) followed by selection (4,063 kg / ha) and local variety (3,000 kg / ha). Straw yield was 19.5% more in SRI than in the conventional method. Approximate estimation of cost of cultivation showed that the cost / ha in SRI was Rs. 23,550 whereas it was only Rs. 20,650 in the conventional method. The cost increase was primarily due to the higher labour requirement in SRI, but this is more than compensated by the higher yield and greater efficiency of resource use.

2.3 Evaluation of Cashew Genotypes

A. Kailas and A. L. Joshi

Cashew is a popular species among farmers who participate in land-based development projects implemented by BAIF. The common variety of cashew grown in Thane district of Maharashtra is Vengurla-4. In order to assess the potential of other cashew varieties available in the country and to have greater genetic diversity for future plantations, an on-farm evaluation was initiated in 2005. Grafts of 12 varieties that are known to be among the best performers in Kerala, together with Vengurla-4 for comparison, were planted on farmers' fields selected for the study. Preliminary observations based on survival, plant height, canopy size and yield have identified six promising varieties. They are Madaktara-1, Madaktara-2, Dhana, Priyanka, H-1600 and H-1610. At five years, nut yields of these trees ranged from 0.53-1.42 kg / tree whereas that of Vengurla-4 was 1.18 kg.



Madaktara-2 variety of cashew

2.4 Micronutrient Supplementation

P. M. Patel, M. M. Patel, R. K. Baria, H. M. Vastani, D. L. Bavalia and V. B. Madora

Deficiency of micronutrients is known in many parts of the country. A reason for this may be the continuous cultivation of land without replenishing micronutrients removed by crop uptake. A series of on-farm studies were conducted in two districts of Gujarat to investigate crop response to boron and zinc supplementation. These two micronutrients are usually deficient in the study area. Boron and zinc were applied in the form of 5.0 kg / ha of Agribor and 25 kg / ha of zinc sulphate, respectively. The test crops were groundnut and wheat in Bharuch and Junagadh districts, soybean in Bharuch and chickpea in Junagadh. All the crops in the study responded positively to micronutrient supplementation (Table 3). The average yield increase ranged from 26-46% in the crops under study. As this increase is achieved with relatively small expenditures on inputs and labour, farmers can benefit by applying micronutrients in crop production.

Table 3. Crop response to boron and zinc supplementation.

Crop	No. of farmers	Season	% yield increase
Groundnut	25	Kharif	46
Soybean	15	Kharif	32
Chickpea	26	Rabi	26
Wheat	10	Rabi	27

2.5 Integrated Nutrient Management of Mango

J. N. Daniel, G. V. Hegde and V. C. Badve

The expansion of mango cultivation in the country has resulted in the establishment of orchards even on land of low fertility. Realisation of the fruit yield potential on such lands requires the application of crop nutrients as organic manure or fertiliser. The cost of organic manure is high and its availability is limited whereas use of fertiliser in large quantities is undesirable. Therefore, the integrated nutrient management (INM) of combining manures and fertilisers is a desirable strategy. In order to examine the effect of INM on mango fruit yield, on-farm trials were conducted in Gujarat and Karnataka. At the time the trials were started, the orchards in Gujarat and Karnataka were 12-15 years and 7-8 years old, respectively. In addition, an on-station trial was also initiated in Karnataka on a four-year old mango tree stand.

A survey of 100 farms in the Vansda area of Gujarat showed that not many farmers follow the practice of applying manure or fertiliser every year. Application of crop nutrients is more frequent for intercrops than mango. In general, farmers were unable to provide definite information about the exact fertilisers and the quantities applied for mango or intercrops. Soil analysis showed a wide variation even within a farm and hence caution is necessary in making generalised recommendations. In the on-farm study, fruit yield differences due to imposed treatments were not discernible. Besides the experimental variation, another reason for this lack of response is the relatively low rates of fertiliser and / or manure application. In order to reflect what farmers of the area can afford, the rates applied for the study were kept low. However, the applied quantities were inadequate to produce a response on trees that were 12 years or older. A relatively high degree of experimental variation was encountered in the trials at both locations because they were conducted under on-farm conditions in already established orchards.

The treatment effects in the Karnataka trials, though not significant, showed some trends in their fruit yield response. Although these did not have year-to-year consistency, the average of the four years showed the treatments receiving INM with irrigation and only organic manure to be superior to others. A similar response was reflected in the intercrop yields as well. Hence, for soils of low fertility and moisture stress, the recommendation should be to adopt an INM strategy with irrigation if farmers have the facility. The high variability in the experimental units in Karnataka was further aggravated by the continuous drought after the first year. As a result, the yields were mostly less than 10 kg / tree while it was around 40 kg in Gujarat.

2.6 Integrated Pest Management of Cotton

M. M. Patel and P. K. Sharma

Pest management of cotton has traditionally relied on synthetic insecticides. The use of chemicals on cotton is very high because of its susceptibility to many pests. The dependence on pesticide has several environmental and economic disadvantages such as development of insecticide resistance in key pests, reduction in beneficial insect population and increase in cost of production. Integrated Pest Management (IPM) can reduce the use of pesticides. Therefore, IPM experiments were conducted with biopesticides on farmers' fields in Bharuch district of Gujarat. Each farmer set aside 0.4 ha of cotton for the study and divided the plot equally between IPM treatment and chemical pesticides. The IPM management consisted of weekly spray of neem vermiwash (100 ml in 10 l of water), neem kernal extract (5%), neem leaf extract (10%), entomopathogenic microorganisms (*Bacillus subtilis* BCB 19 and *Metarrhizium anisopliae*) and cow urine (10%). The average cotton yield was 1,487 kg / ha in the IPM plot as against 1,379 kg / ha in the chemical plot. There was also a saving of Rs. 2,090 in the input costs of IPM plots. The results of the trials conducted over two years showed that the cotton crop can be protected successfully with biopesticides alone. Some of these biopesticides can be produced by rural enterprises, providing employment opportunity to rural people. Others such as microbial sprays have to be produced in more sophisticated laboratories. The experiments demonstrated that IPM can be an effective alternative to synthetic pesticides for the protection of cotton.

2.7 Floriculture as a Component of Wadi System

A. Kailas and A. L. Joshi

The tree-based farming system, popularised by BAIF as wadi, has fruit trees as the main species component. Most of these tree species come into production in 3-4

years after establishment. This is a relatively long gestation period for small farmers, so alternative sources of income are necessary. Floriculture in small plots is an ideal income generation activity as the returns can be realised within a short period of time with the income distributed throughout the year. It can also make use of the interspaces between the fruit trees. Hence, an on-farm study was initiated with 30 farmers in Thane district of Maharashtra. This mixed floriculture model has jasmine and rose as perennials while aster, gaillardia and marigold as seasonal species. Grading of the farms based on the floriculture activity and the income showed that jasmine is more suited for wadi conditions than other species.

Table 4. Income and number of farms under each grade.

Species	Income (Rs.)	Number of farms		
		Excellent	Good	Average
Jasmine	750 - 800 / month	10	13	03
Rose	100 -120 / month	03	05	07
Marigold	900 - 3,500 in two months	04	05	11
Total income from floriculture (Rs.)	-	4,987	2,317	1,467

2.8 Analysis of Marketing Potential of Processed Amla

D. Brueckner and G. B. Singh

Prathapgarh district of Uttar Pradesh is the key amla production centre of the country. It has many small and large units that process amla fruits into a variety of products. As BAIF promotes the establishment of amla orchards in its development projects in the area, it is necessary to understand the emerging market scenario. Therefore, the market potential and the strategies adopted by different amla stakeholders were studied by conducting a survey of processors and retailers. Semi-processed amla can be stored for about six months. This ensures amla processing work for about 200 days in a year; the units processed other fruits and vegetables during the remainder of the year.

There are some shops selling amla products exclusively whereas others have a more diverse product range. Accordingly, the proportion of income for these retail outlets from the sale of processed amla ranged from 20-75%. Among the amla products, the important ones are murrabah, burfi, laddu and pickles. The most popular product is murrabah and its sale alone accounted for 33-60% of the income of some shops.

Small processing units obtained fruits from their own farms and also sourced raw material locally to make full use of their capacity. Larger units have farmers as well as suppliers who collect fruits from farms. In addition to sale of products in nearby cities and towns, they are also supplied to retailers in other states. Large processing units have their own retail outlets for local sales and established channels for marketing their produce in other states. Prices vary according to the location of the shops and the quantity of the purchase. The processors recognise the importance of packaging and labelling and change the labels while participating in exhibitions to suit the organisers. Obtaining credit for the activities, suitability of machinery and small profit margins due to competition are the important problems faced by amla processors.

2.9 Value Chain Analysis of Underutilised Fruits

J. N. Daniel and P. A. Dudhade

Value chains of underutilised fruit species have not been adequately analysed. Therefore, a study was conducted to understand the value chains of amla (*Embilica officinalis*), tamarind (*Tamarindus indica*) and kokum (*Garcinia indica*). The methodology for data collection included personal interview, individual interaction and group discussion. Information for amla was collected from three locations in the states of Rajasthan and Uttar Pradesh while the study sites for tamarind and kokum were confined to Maharashtra. The key information collected for each species was on the cost of orchard establishment and aftercare, fruit production and returns, quantity and income of intercrops and by-products, all aspects related to processing and prices at processor, wholesaler and retailer level.

In Udaipur district of Rajasthan, the total expenditure on the establishment of 40 amla grafts and their aftercare up to the age of eight years was Rs. 12,950 and the cumulative value of fruits produced was Rs. 22,250. The returns were about 20% higher in Pratapgarh district of Uttar Pradesh as the soil fertility and moisture availability are more favourable. Therefore, the investment is recouped in 4-5 years in Pratapgarh whereas it takes 7-8 years for this to happen in Udaipur. A processing unit can obtain fresh amla fruits for about 5-6 months in a year and the main processed products are pickle, squash, sweets and candy. Value addition in amla ranged from Rs. 5.25 for mouth freshener to Rs. 51 for candied pulp. An analysis of profit distribution of candied pulp showed that the returns / kg of amla was only Rs. 1.50 to the farmer compared to more than Rs. 8 to other players in the value chain.

Returns from tamarind start in the sixth year and the investment on establishment and aftercare of the orchard can be recovered by the eighth year. On the other hand,

farmers who had irrigation facilities raised annual crops in the interspaces, which was a highly remunerative intervention. Such orchards had a income surplus by the second year itself. New product development in tamarind is limited and the condiment value of pulp still remains its predominant use. Sauce, pickle, toffee and dried pulp powder are the other products of tamarind. Value addition by processing one kg of fruit into pulp and toffee are Rs. 33 and Rs. 60, respectively. However, there is no established demand for products like tamarind toffee and amla candy. Small processors appeared to be averse to the risk associated with such value-added products because the profit margins are unattractive at present.

The economics of kokum production is similar to that of amla in orchards planted with 30-40 grafts with intercropping for additional income. Presently, there are several kokum-based production practices where its presence ranges from a few trees to naturally-established dense plantations. Depending upon the number of trees, size and vigour, the income from kokum varies from Rs. 300 to Rs. 3,350. The scattered occurrence of kokum trees provides a livelihood opportunity for fruit collectors. Those engaged in this activity collect or buy fruits and supply them to processing units, earning Rs. 5,000-7,000 during the fruiting season of 2-3 months. The cost of rind and syrup, the common products of kokum, processed by households is more than 30% lower than that of commercial processing units.

Fruit yields were below the potential for all three species in the study. The probable reasons for low productivity are the inferior quality of land allotted for these species, inadequate input application and management, high tree-to-tree and year-to-year yield variation. Small-scale processing with appropriate market linkages can help reduce the number of intermediaries in the value chain and thereby increase the share of the profit that goes to the growers. Enhanced processing technologies that can preserve the nutraceutical value of the study species have to be developed. Credit facilities and information support systems dealing with all aspects of the value chains are other requirements for the successful promotion of underutilised fruit species.

2.10 Impact Study on Mango Wadis

A. Joseph

Mango orchards (wadis) were established in Banswara district of Rajasthan under a comprehensive rural development project implemented by BAIF during the period 1996-2006. The impact of this activity was assessed in 2007 by collecting information from project participants. The overall objective of the study was to examine the state of the wadis in terms of survival of plants, fruit production and the continuation of introduced technologies. Information was collected with an

interview schedule, focused group discussions, participatory rural appraisal and general observations from randomly selected participants from each wealth category and year of wadi establishment.

It was found that establishment of wadis has not only improved the economic status of participants, but has also changed their social conditions. The impact in the economic status of participants was the result of income from both mango and intercrops in the wadi. The category to which the beneficiary belonged had a bearing on the establishment of the wadi, survival of the plants, plants in fruiting and average fruit yield / plant. Those belonging to the lowest wealth category had less capacity to provide nutrition and aftercare compared to others. Their farms are on uplands and irrigation facilities are also limited. Moreover, their level of awareness was low compared to other categories.

As far as input application is concerned, most of the participants do not follow recommended application schedules for manure and fertiliser. Consequently, fruit yield has not been increasing with the maturity of trees. The cropping intensity has increased as most of the participants are able to grow a second crop every year. This is because of the increased availability of water due to the land development work carried out. In general, the participants are familiar with orchard management practices such as spraying of pesticides, tillage practices, irrigation and application of manure. But all the management practices are not followed by those who have fewer surviving plants as they resort to off-farm activities. Technologies and practices introduced are farmer friendly, but the benefits can be realised only if the practices are sustained by participants.

2.11 Low-Cost Zero-Energy Cooling Chamber for Vegetable Storage

P. K. Sharma and V. V. Patel

Storage of vegetable is not a common practice in rural households because not many of them have refrigerators and assured supply of electricity. As an alternative, a zero-energy chamber based on evaporative cooling has been developed. A study was conducted at the Krishi Vigyan Kendra at Chaswad in Gujarat to assess the quality and shelf life of vegetables in this cooling chamber. Freshly harvested vegetables were placed in perforated plastic bowls and stored in a refrigerator, at room temperature and a zero-energy cooling chamber.

Coriander had the shortest shelf life of only one day at room temperature, but it improved to four days in the cooling chamber. In the refrigerator, coriander leaf suffered chilling injury after two days. The shelf life of brinjal improved from three days at room temperature to seven days in the cooling chamber. Similarly, the shelf



The cooling chamber

life of chillie and okra also increased in the cooling chamber. In cabbage, shelf life was 14 days in the cooling chamber, but only seven days in the refrigerator and room. Cooling chamber retained the quality of stored vegetables, except for the occasional appearance of fungus growth. The cooling chamber was fabricated using 24 gauge GI sheet in a drum shape with 60 cm diameter and 60 cm height. It was covered with viscous material made of cotton. During the experimental period, a small plastic bowl with wetted viscous material was kept inside the chamber to regulate humidity and the viscous material on the outer surface was wetted by continuous dripping of water from an overhead bucket. As this cooling chamber requires no mechanical or electrical energy and is easy to install with cheap locally-available material, it is a suitable option for storage of vegetables.

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2.12 Training Needs Assessment

R. K. Bariya and P. K. Sharma

Mango-based farming is a successful intervention for tribal farmers of Bharuch district in Gujarat. It is necessary to improve the knowledge of farmers on all aspects of mango cultivation to increase the productivity. The training needs of farmers were assessed in three sample villages of the district. It was found that 93% of mango growers had less than 2.5 ha of land while others had 2.5-5.0 ha. The survey found that a majority of mango growers had medium level of adoption of scientific mango cultivation and the rest had low level of adoption. Not a single respondent adopted practices that can be considered highly scientific mango cultivation. The mango growers of the area overwhelmingly identified technical training as one of their requirements for mango cultivation. Only 9% of the respondents said that they do not require any training. All those in the survey indicated that the training should include insect and disease control, 80% selected manure and fertiliser application, irrigation management was identified by 68% and processing was found to be important by

57%. It is apparent from the study that mango growers need training in several production and processing aspects.

2.13 Probiotics for Silkworm

K. K. Singh, R. M. Chauhan, A. B. Pande and S. B. Gokhale

Probiotics have favourable effects such as improved growth and resistance against diseases on silkworm. Research was carried out to induce probiosis using beneficial bacterial consortia and testing the efficacy of developed probiotics by performing bioassays. Whole mulberry leaves of different maturity were processed and inoculated in nutrient broth and incubated at 30°C for 24-48 hours. The types of bacteria growing in the broth were detected by carrying out Gram staining. A loop of the broth culture was streak inoculated on Nutrient Agar and MRS Agar, respectively, and incubated at 30°C for 24-48 hours. The isolated colonies of the bacteria were identified by studying the morphological, cultural and biochemical characteristics. Guts of ten healthy silkworm larvae of third, fourth and fifth instar were dissected aseptically and gut contents were suspended and homogenised in 10 ml normal saline solution and used for isolation of bacteria. Five of the isolates were identified as new sub-variants of *Bacillus subtilis* and accredited with the National Centre for Biotechnology Information.

The use of *Lactobacillus plantarum* as a pro-biotic to improve silkworm production was studied by feeding the larvae with mulberry leaves treated with the pro-biotic bacteria. Observations were made at all the instars on larval body weight, cocoon weight, shell weight, shell ratio and pupation percentage. The treated worms had higher values for all the parameters than those in the control treatment. The pro-biotic bacteria probably induced the production of certain growth promoters. The physiology related to this aspect has to be further investigated.

In another study, the effect of pro-biotics *Lactobacillus plantarum* (NCIM-2083) and *Sporobolomyces roseus* (NCYC-1463) on silkworm and Nuclear Polyhedrosis Virus (NPV) were examined. Leaves of mulberry variety S-1635 were smeared with a suspension of the probiotics after partially drying the leaves at room temperature for experimentation. The treated leaves and fresh leaves as control were fed to different batches of fourth instar larvae of silkworm. Those fed on treated leaves had higher larval weight, cocoon weight and shell weight and greater resistance against infection than those in the control.

2.14 Moisture Conservation in Biomass-Filled Trenches for Mulberry

I. I. Hugar, B. N. Champa and Y. A. Thakur

The current practices for mulberry cultivation in Karnataka involve the application of high doses of fertiliser and / or manure together with irrigation. As a result, only farmers having irrigation facilities and afford to invest in inputs could take up sericulture. In order to expand sericulture among farmers with lesser resources, an innovative soil conservation practice was investigated on farmers' fields. The method involved digging trenches of 3.0 m x 0.5 m x 0.5 m across the slope, filling them with green / dried biomass and covering the upper surface with soil. This practice resulted in favourable changes in plant and soil characteristics.

Moisture retention in the pits probably enhanced the moisture status of the soil between the trench and roots. Stimulated by this condition, root growth was higher on the trench side of mulberry plants compared to the side away from it (Table 5). There was a marked increase in the number of primary roots and root length on the side of the trench and this was even higher than in plants receiving irrigation. Analysis of the upper 30 cm layer of the soil showed an increase in most of the nutrients near the trenches during normal rainfall years.

Table 5. Influence of biomass-filled trench on root growth in mulberry.

Root parameter	Rainfed with trench		Irrigated plant without trench
	Trench side	Opposite side	
Primary roots (no.)	3.66	2.33	3.33
Longest primary root (cm)	114	66	74
Highest root circumference (cm)	6.36	-	5.50

2.15 Sericulture in Himachal Pradesh

K. K. Singh, A. B. Pande and D. K. Tiwari

The wild mulberry (*Morus serrata*) growing on forest land and farm bunds in Gohar block of Mandi district of Himachal Pradesh was examined as an alternative feed for silkworm. In spite of having lower protein and carbohydrate contents than *Morus alba* variety S-1635, it produced 40-45 kg / 100 disease-free layings (dfls) with a shell ratio of 17-19.5%. This wild mulberry has the potential as a feed material, especially for silkworm of later instars. Extension studies on sericulture were conducted in Mandi

district by establishing mulberry plantations of improved varieties on farmers' fields and Government farms. Green cocoon yields averaged 45-55 kg / 100 dfls for M-5 and S-1635 varieties. Variety S-1635 was suitable for irrigated conditions while S-146 performed better under unirrigated conditions.

3. Water Resource Development

3.1 Water-Centric Livelihood Strategy for Tribal Areas of Maharashtra

B. K. Kakade

Maharashtra state has 9.3% of the total tribal population of India and it is distributed in 16 districts. Depending upon local conditions, the tribal communities are engaged in agriculture or work as labourers. A study was conducted with the objective of developing water-centric livelihood enhancement strategies for tribal regions of Maharashtra. The parameters assessed were tribal culture, livelihood systems, land use pattern, food security, fodder security and drinking / irrigation water access. Information was collected through secondary sources, participatory rural appraisals and household interviews. Selection of study villages was based on physiography and rainfall classifications. They were Rain Rich Eastern Vidharbha (district Chandrapur), Moderate Rain Western Ghats (district Nandurbar), Moderate Rain Undulating Hilly Mountainous Area (district Yavatmal) and Rain Rich Western Ghats (district Thane).

Literacy in the study villages is 55% and a majority of the people (86%) own land, but most of them are marginal (27%) or small farmers (42%). Average land holding is 1.70 ha. Rice, pigeonpea and soyabean are the main kharif crops while 17% of the land is cultivated during rabi with crops like chickpea and wheat. Availability of irrigation water is the major constraint to food production as only 8% of the families have private wells for this purpose. Source of water for irrigation is stream for 2.6% of the people and canal, pond or traditional water sources for 3.1%. Food insecurity among tribal people is very high: 32% of the population is totally dependent on wages or other sources for meeting their basic food requirement; 48% depend partially on wages; and only 20% of the households have their own source of food. Half of the population regularly migrates for wages to ensure food for the family. Overall, 54% of the working population between the ages of 19 to 60 years migrates. Livelihood



Communities depend on water bodies

opportunities are limited and 28% of the population (14% marginal land holders and 14% landless) is struggling to find some livelihood opportunity.

The main crop grown in all the regions is paddy. Productivity of rice is only 1,090 kg / ha, which is far below the state average of 1,990 kg / ha. Hence there is scope for yield improvement. Wheat is the only irrigated crop and its yield is about 1,600 kg / ha. Yields of other crops are low as they are grown on residual moisture. The productivity of land is low because crops are unirrigated and mostly there is no second crop grown. The potential of livestock-based systems have remained unexplored probably due to limited fodder availability. It is evident from the assessment that the focus has to be on the development of decentralised water resources and alternative farming systems. The target should be to improve the kharif crop yield besides bringing at least 50% of the cultivable area during rabi.

A flexible approach is required while developing livelihood programmes for tribal people. Technically, a regional plan having a combination of appropriate interventions and a micro-plan for individual households should be developed. Based on individual household resources and the available water in the area, members of the local community, together with the programme implementers, should identify suitable interventions. A combination of traditional practices and innovative water conservation measures has been proposed on the basis of local physiographic, geo-hydrological and agro-climatic situations.

3.2 Impact of Watershed Development on Crop Productivity

G. N. S. Reddy, J. N. Daniel, P. K. Pradhan and GRISERV Watershed Team

A highly successful activity of BAIF in Gujarat is the implementation of watershed development projects. An impact study was conducted in selected watersheds to assess the changes brought about by project interventions. Comparisons were made between projects implemented by BAIF and other agencies. Similarly, watersheds with higher natural resource conditions were compared with those in which the populations were predominantly tribal communities having limited resources. The study included group discussions, visual observations and a survey of 25 randomly selected project participants in each watershed studied.

The primary benefit of any watershed activity is increased water availability, which was observed in the study as well. This resulted in increased crop productivity (Table 6). Farmers in all the watershed categories in the study cultivated cotton and wheat. Maize was not grown in the tribal watersheds of the other organisations in the study whereas paddy was grown only in tribal watersheds. Yields of all the crops, except

maize in BAIF watersheds, were positive and the increase was substantial in most of them. It is necessary, however, to analyse this positive crop response cautiously. The values for after watershed in the tables are for the year 2006, which experienced above normal rainfall in the study areas. Additionally, the use of improved crop varieties or hybrids has increased. For example, BT cotton was grown in less than 30% of the area in 2005, but it has increased to about 80% in 2006. As satisfactory rainfall and new crop varieties also contributed substantially towards increase in productivity, the benefits cannot be attributed to watershed development alone.

Cotton yield increase was higher in non-tribal watersheds than in tribal watersheds. This may be due to the higher economic status of non-tribal farmers, enabling them to invest on additional inputs such as fertilisers. Wheat yield increased by about 35% in most of the watersheds. In the non-tribal watersheds of organisations other than BAIF, the initial wheat yield itself was high, so the increase after the development activity was relatively small. A similar trend was also seen in paddy where the yield in watersheds of other organisations was relatively high even before the development initiatives, so the increase was only 9% as against 77% in BAIF watersheds. There was a decline in maize yield in non-tribal watersheds of BAIF. The reason for this is unknown, but it is possible that the shift in focus to other crops may have resulted in negligence of maize.

Table 3. Influence of watershed activity on crop productivity.

Crop	BAIF watersheds		Non-BAIF watersheds	
	Tribal	Non-tribal	Tribal	Non-tribal
1. Cotton (kg / ha)				
- Before watershed (ha)	750	2165	644	2775
- After watershed (ha)	1014	3265	740	4162
- Percentage change	+35	+51	+13	+50
2. Wheat (kg / ha)				
- Before watershed	1500	2778	816	5181
- After watershed	2041	3586	1099	5986
- Percentage change	+36	+29	+35	+15
3. Maize (kg / ha)				
- Before watershed	582	4400	-	780
- After watershed	835	3218	-	913
- Percentage change	+43	-27	-	+17

3.3 Water Resource Use for Improving Farm Productivity

B. R. Patil, A. B. Pande, S. Rao and S. K. Dixit

Success of a land-based activity largely depends on those who make use of natural resources. A successful approach in this regard is the Farming Systems Research (FSR), which integrates the roles of farmers, scientists and extension workers. This approach was attempted in Vidisha district of Madhya Pradesh to understand the various technical and socio-economic relationships between productivity of rain-fed farming and resource use. On-farm trials were conducted for several seasons with soybean during kharif and chickpea during rabi on irrigated land. The main interventions were improved varieties, micronutrient application and broad bed-furrow configuration. Soybean yield was 1,712 kg / ha with micronutrient application, 1,505 kg / ha with broad bed-furrow and 1,281 kg / ha in the traditional method. Economic analysis of the production data showed that the profit increased by more than Rs. 4,000 per ha because of the interventions. Although production costs increase, they are more than compensated by the higher yields. Water logging is a serious problem in the study area. Farmers in general showed interest in adopting the interventions as they were able to see the benefits of the new technologies.

4. Social Outreach and Community Health

4.1 Livestock Activity of SHG Members

P. Pradhan, V. Halwe and R. K. Mahuli

Microfinance through SHGs has evolved as an effective delivery mechanism in the Indian context. A large number of women SHGs promoted for social and economic empowerment are getting linked to banks with the assistance of non-government organisations and financial institutions. BAIF has formed 213 SHGs consisting of 3,755 women in and around Urulikanchan in Pune district. Many of these women have obtained loan from their SHGs and purchased cows to supplement the family's income from agriculture. A study was conducted to understand the processes in this activity, its impact on daily lives and household income, and identify potential opportunities that can make improvements. It involved individual interview with 30 women, belonging to 16 SHGs, who had availed loan from their groups.

Information was collected on basic aspects such as education, family composition and household income. In addition, specific information on livestock activity such as cow selection, purchase and financing, management and income was also obtained. It was found that there are mutual benefits to be had by having agriculture and

livestock as crop waste can be used as animal feed and dung can be used as manure. Thus, it is less expensive for land-owning households to have a cow than it is for the landless. In households with small children, the activity is chosen with a dual purpose of milk to drink at home and sell the surplus. Purchase of a pregnant cow is mostly preferred as it would start producing milk soon. Loan from SHG usually covered 72% of the purchase price of the cow.

There is scope to improve the technical knowledge of the women on feeding of cows. Many of those interviewed do not feed mineral mixture and are unaware of its importance. The benefits of feeding fodder are also not well understood. Similarly, many of them did not know what to look for in a cow before buying it. The desire to improve the milk business also seemed to overshadow the importance of taking better care of the cow. In order to impart knowledge, the training module should have less classroom instruction and emphasise more on visits to observe others with best practices within the community. Most interviewees feed their cows concentrate, which is purchased directly from the dairy to which they supply the milk. This is convenient because the cost of feed is deducted directly from the payment for milk.

4.2 Development Fund for Self Help Groups

V. Halwe

The concept of SHGs has emerged as a powerful tool for the socio-economic empowerment of vulnerable sections of the society, especially women. SHGs are usually formed with support available from sponsored projects. It has been found that even after they are well established, most groups need guidance through Village Level Workers (VLW) who are usually supported by the promoting voluntary organisations. However, this will entail expenses that have to be recovered at least partly from the community. Charging for the guidance provided after groups become stable and generate surplus not only would make the programme economically viable, but would also promote the culture of fee-based support. Therefore, BAIF initiated a Group Development Fund (GDF) for SHGs to contribute for their development and continued association with the organisation.

Due to lack of previous experience, the amount to be contributed to the GDF was decided arbitrarily depending on the age of the group. It was purely a token amount, irrespective of the surplus a group generated, its grade or the number of times facilitation might be required. The contribution / member / year at present is Rs. 12 in the first year of the SHG and Rs. 24 thereafter. A study examined the abilities of VLWs to guide SHGs, their success in convincing the SHGs to a fee-based support and the expectation of the members. The methodology consisted of focus group

discussions and analysis of secondary data. Groups that had contributed for 2, 3 and 4 years to the GDF were selected for the study.

It was found that VLWs sometimes had difficulty in discussing the issue of GDF payment, but they understood their role and the importance of collecting funds. They feel the need for back up support from BAIF for them to function effectively. The use of the fund for meeting the expenses of VLWs was acceptable to most SHGs. But how the fund is spent, whether it is adequate and what contribution BAIF makes to the activity are unknown to many SHG members. Although groups were reluctant in the first year, the situation has now changed. Most SHGs felt that GDF should be linked to their profit. Older SHGs have got used to getting inputs without any cost for a long time, so they show resistance to GDF contributions. They also expect better facilitation, more guidance and presence of staff.

Analysis of the secondary data showed that the credit available to members and the profit in the form of service charges collected from loans are increasing. The expenses of the groups are also increasing with age and the reasons for this have to be further analysed. SHGs find it difficult to pay the GDF in the first year because the expenses incurred by them are more than their income. But with time, besides the improvement in their fund reserves, they are also able to access outside loan. The increase in the number of SHGs contributing to the GDF shows that the concept of paid services is acceptable, but the funds collected are insufficient to meet the honorarium of VLWs and other expenses.

4.3 Micro-Finance in Watershed Development Programme Areas

A. L. Joshi

Watershed development increases water availability and thereby enhances crop and fodder production. This in turn raises the income of people, which is reflected in the standard of living and asset creation. The overall development influences the informal finance and formal banking in order to meet the credit needs. Therefore, whether holistic natural resource development has had an effect on the savings and credit behaviour of those participating in SHG activities was investigated in Bundi district of Rajasthan and Hassan and Tumkur districts of Karnataka. Baseline and financial profiles of SHG members of selected sample was collected from records. Based on this data, information was collected from five financially successful SHGs through focus group discussions with members of the Village Watershed Committees and questionnaire-based interview. Farm ponds and check dams have increased the water availability in both study locations. Many people have deepened existing wells or dug bore wells on their personal land.

Crop production has increased with the use of improved varieties and organic manures / fertilisers. The shift in cropping pattern from staple food crops to a combination of cash crops and livestock has resulted in a rise in income. Easy availability of technical advisory and production inputs has further accelerated the development process. The cumulative effect of all these development activities is the increase in savings and credit through SHGs. Out of the total credit, 22% is taken through linkages with banks or voluntary organisations. This is reflected in the improved performance of bank branches where SHGs are active. In Rajasthan, however, credit growth was less effective because of the stoppage in credit delivery after one cycle, change in the structure of SHGs and moneylenders providing credit at competitive interest rates.

The relationship between livelihood and credit is evident in the manner in which the funds are used for agriculture and livestock. In Karnataka, credit has helped diversify agriculture to replace existing crops that are susceptible to pests and diseases. There is a switch over from coconut to horticultural crops. Gherkin, vegetables and banana have emerged as cash crops. Additionally, credit has resulted in the emergence of dairy as an alternative farm enterprise. Crop diversification in Rajasthan has resulted in the introduction of high-value basmati rice, sugarcane, soybean, mustard and wheat. A part of the additional income was used for the repayment of loans and the remainder for land improvement.

4.4 Project-Influenced Social, Political and Economic Changes in Women

D. Brueckner and G. B. Singh

The development initiatives under the project sponsored by the European Union during 1996-2006 included several components for the empowerment of women. A major activity in this regard was the formation of SHGs. Most of the groups in the project location of Raniganj in Pratapgarh district of Uttar Pradesh have been very effective in realising the objectives of women empowerment. The gains of women in the project areas were compared with those in nearby non-project villages.

Participation in SHG activities has improved the confidence and social standing of women considerably. This change has encouraged women in non-project areas also to form SHGs to enhance their social conditions. Women in project villages have been trained in health and child care and are familiarised about the importance of hygiene in daily life. This has greatly reduced the incidence of several health problems. Although women's health in non-project villages has also improved in recent years, the situation in project villages appears to be better. Literacy in the area was generally low and there was no difference between project and non-project villages in this regard.

Women in project villages earn Rs. 15-60 daily by engaging in vermicomposting, cattle and goat rearing, and agricultural activities. This amount is about 30-40% of the daily family income. The income of women in non-project villages was similar, but most of them work as labourers and their income is seasonal. Availability of loans through the SHGs has improved the funds availability of women in project areas to meet their various needs and improve their standard of living. SHGs in non-project villages are relatively new and have not reached the stage where they can easily avail of loans. Women have 30-50% representation in village committees of project villages, but it is lower in most non-project villages. Thus, it is evident that women have benefited in various ways by project initiatives.

4.5 Efficacy of Double-Fortified Salt

S. R. Deshpande, S. Singh, B. S. Parmar, O. P. Mishra, S. S. Upadhyaya, B. B. Bhalia and others

Although iron is not a limiting factor in typical Indian diets, its bio-availability is low because of the low intake of meat products and the inhibition of absorption by phytates in the staple food. Double-fortified salts (DFS) are a possible method of supplementing iron and iodine. In order to test the stability of DFS during storage and assess its nutritive efficacy on vulnerable communities, a study was conducted in seven locations. In each location, one group used DFS and the other used iodised salt for all the food preparations at home. Haemoglobin content was determined on 2-3 randomly-selected members above the age of 10 years in each family at the beginning of the study as well as six and 12 months thereafter. Deworming of the participants was done at these three stages. Urinary iodine was determined in one location at the beginning and end of the study.

Use of DFS in food preparations for one year resulted in an increase of 1.98 g / dL of haemoglobin. The haemoglobin content of the group that received iodised salt also increased by 0.77 g / dL, but this may have been due to deworming. There was a significant increase in the median urinary iodine content in iodine-deficient individuals in both groups. This shows that DFS was as efficient as iodised salt in increasing urinary iodine content. There was a statistically significant increase in haemoglobin in all seven locations in the group receiving DFS compared to the iodised salt group, which was probably due to the increase in bio-available iron.