The objectives of the study were: to characterise household resources and determine their interdependencies and relationships, to find out the levels of adoption of dairy production technologies and to estimate milk production levels of crossbred cows and calf growth performance under farm conditions. The study sites Bilalo and Lemmu, are located in the Arsi highland of Ethiopia. The sites were selected because it was in these areas where major crossbreeding and dairy development activities were undertaken by CADU/ARDU/SEAD projects and as the result, crossbred animals were mainly concentrated here.

The methods of data collection were a combination of formal survey, on-farm performance monitoring and the use of secondary data. A total of 204 farmers, 96 from Bilalo and 108 from Lemmu, who reared crossbred dairy cows, were interviewed once through questionnaires between Jul. 96-Feb. 97. Service co-operative lists were used to select the farmers in question, in other words, a sub-population of farmers in the area, i.e. all those with crossbred animals were included in the survey. For dairy performance study, however, a random sampling technique was employed, although accessibility of the area was considered in the selection too. In this case, 68 farmers, 37 from Bilalo and 31 from Lemmu, with crossbred animals in their herd were monitored for milk production, calf growth and mortality from July 96 to May 98. The information collected included: household size and household age structure, livestock number and composition, cattle herd composition, cattle breed composition, farm size, cultivated area, grazing area, grain production, costs and income from crop and livestock activities, livestock management practices and information on dairy technology adoption, which were: concentrate feeding, forage cultivation, bucket feeding, pasture fencing, cow shed and AI service utilisation. The recorded milk production and reproductive traits were: lactation length, lactation yield, 305-days lactation, annual yield and calving interval. Factors affecting milk yield and reproduction such as upgrading levels, lactation number, season of calving, year of calving and calf rearing method were also recorded. Factors affecting calf growth such as dam upgrading levels, parity, sex, season of birth, year of birth and calf rearing methods were recorded. Calf mortality was also recorded.

The overall mean for household size was 7.9 persons per family with an average household size of 7.8 and 8.0 for Bilalo and Lemmu, respectively. The overall mean proportions of children and adults in the area were 61.3% and 38.7%, respectively. The smallest proportion of the population was for those older than 50 years with overall proportion of only 5.8%.

The average farm size in the area was 4.27 ha per household, 4.81 ha for Bilalo and 3.79 for Lemmu. The average cultivated area was 2.44 ha or 57.1% of the farm size, with 2.67 ha at Bilalo and 2.22 ha at Lemmu. The average holding of grazing land was 1.56 ha of 36.5% of the farm size with households at both sites allocating equivalent amount of area for grazing. Farmers on average allocated 1.22 ha or 500/o of the cultivated area to barley, which was the dominant crop in the area. The second most important crop was wheat with an average allocation of 0.48 ha or 19.7%. Teff (Eragrostis abessinica) and linseed occupied the least proportion of cultivated, area at both sites. The annual average amount of fertiliser used per household was 3.16 q with 3.95 q and 2.45 q for Bilalo and Lemmu, respectively. Other inputs such as improved seeds, herbicides and insecticides were very small. The annual average grain output per household was 39.53 q and comparable at both sites.

The average livestock holding per household was 21.24 animals or 11.86 TLU, with 10.77 TLU for Bilalo and 12.83 TLU for Lemmu area. Cattle was the most important animal and

constituted on average 80.4% (9.53 TLU) of the livestock herd. The average holdings per household for horses, sheep, asses and goats were 1.61 TLU (13.5%), 0.42 TLU (3.5%), 0.23 TLU (1.9%) and 0.07 TLU (0.6%), respectively. On average, composition of cows was 30.3% (2.89 TLU) of the cattle herd. The proportion of oxen was the largest in the cattle herd which was 43.2%. The overall proportion of cows of local breed (Arsi) in the cattle herd was 16.60/0 (1.58 TLU) and those of crossbred cows was 13.8% (1.31 TLU).

The estimated total amount of annual dry matter supply per household, which was from crop residues, individual grazing area, fodder cultivation and purchased concentrates was 17502 for Bilalo and 15722 kg for Lemmu. Crop residues provided 51.2% and 53.3% of the annual dry matter supply per household at Bilalo and Lemmu, respectively. The annual dry matter supply per household from individual grazing area was estimated to be 40.1 % for Bilalo and 44.4% for Lemmu. The contributions of purchased concentrates and cultivated fodder were small.

In the analyses of crop livestock interdependencies, factors affecting grain production, cultivated area and herd size were studied. Among factors affecting grain yield per household, area cultivated was the only factor which affected the annual grain yield per household significantly at both sites. Relationship between grain yield and cultivated area was the highest as evidenced by the regression analyses. Other factors such as household size, oxen holding and fertiliser amount did not exert significant influences. Cultivated area was, however, significantly influenced by farm size, cattle holding and sheep holding. Herd size per household was significantly influenced by household size, cultivated area and grazing area. The significant and positive effect of household size on herd size would indicate that farmers can probably change the size of their livestock enterprises much more flexibly than their cropping activities since land is scarce, thereby insuring income and livelihood through larger livestock herd. Partial correlation analyses among various household resources showed high and significant correlations. The highest correlation was between oxen holding and herd size which was 0.85-0.90.

Results of dairy production technology adoption showed that forage cultivation, bucket-feeding and pasture fencing were the least adopted dairy production technologies with less than 40% adoption rates. Artificial insemination was adopted by 46% of all farmers. The highest adoption rates were for cow shed and concentrate feeding with over 60% adoption rates.

The effects of credit, extension and age household heads did not influence the adoption of all dairy production technologies. Cultivated area had positively and significantly affected pasture fencing. The adoption of artificial insemination was negatively and significantly affected by area cultivated. The relationship between crossbred cow herd size and pasture fencing technology was positive and significant. However, the relationship between labour devoted to crop production and the adoption of concentrate feeding and cow shed was negative and significant, suggesting that there was a competition between dairy and crop production for labour. The effect of formal education on most of the technologies was positive and significant for concentrate feeding, evidence of importance of education in technology adoption process.

The average contribution of livestock products to gross farm income of households was 47%, out of which, 46% carne from milk and milk products. The overall average gross margin in the study area was 5852 Birr per year, of which, livestock contributed 56%. The high contribution of milk and milk products to farmers' income clearly demonstrates the positive effect of integrating smallholder dairy production in the farming system.

Calving intervals of crossbred cows were found to be very long. The overall means of calving intervals at Bilalo and Lemmu were 558 and 582 days, respectively. Only number of lactation and calving season exerted significant influences. The overall mean for lactation length of crossbred dairy cattle was 363.5 days at Bilalo and 383.7 days at

Lemmu. Year and season of birth had significantly influenced the lengths of lactation. The overall means for lactation yield, 305-days lactation and annual yield were 2235.9, 1850.5 and 1460.6 litres, respectively, for Bilalo. The corresponding figures were 1708.4, 1477.7 and 1064.8 litres, respectively, for Lemmu. Upgrading levels and calf rearing methods significantly influenced the milk yield traits. High grade and hand milked cows produced higher yields than the low grade and partially suckled cows.

In the study area, the growth rates of calves were generally poor. Calves reached 60 and 54 kg at 9 months of age at Bilalo and Lemmu, respectively. Dam upgrading levels significantly influenced body weights of calves at most ages, with high grade dams producing heavier calves. Parity and sex of calves did not influence body weight at most ages. Calf rearing methods showed significant effect on body weights of calves at 210, 240 and 270 days at Bilalo with partially suckled calves being heavier than those bucket-fed calves, At Lemmu, however, calf rearing methods did not influence body weights of calves. Year of birth did not influence body weights at almost all ages, while season of birth significantly influenced body weights at early ages.

Mortality rates of calves were 16.7 and 11,5% for Bilalo and Lemmu area, respectively. The main causes of mortality were diarrhoea and blackleg diseases, accounting for 27.8 and 22.2% of all mortalities, respectively.