Role of credit in the uptake and productivity of improved dairy technologies in sub-Saharan Africa

Socioeconomic and Policy Research Working Paper No. 22

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April 1998

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Acknowledgements

Special thanks are due to Mr Stephen Sandford and Ato Addis Anteneh, respectively former Head and Associate Scientist of Livestock Policy Division, International Livestock Centre for Africa, who initiated the project. The authors of various chapters of this document carried forward the initial ideas and implemented the project. The study was implemented under a collaborative arrangement between the International Livestock Research Institute (ILRI) and teams of scientists in Uganda, Kenya and Nigeria. The success of the project depended a lot on the excellent work that the collaborative teams did. Girma Taye and Nega Gebresellasie provided valuable computational assistance in finalising and synthesising the results. Preliminary results of the study were presented at a seminar at the African Development Bank, Abidjan. Participants at that seminar provided useful comments. Brent Swallow and Chuck Nicholson also provided useful comments on earlier drafts of certain sections of the report. However, usual disclaimer applies.

The African Development Bank and ILRI provided funding for the project.

Executive summary

Livestock contribute up to 35% to agricultural gross domestic product in the sub-Saharan African countries when the value of traction and manure are included along with meat, milk and hides. However, in the recent past demand for meat and milk has been increasing faster than domestic production resulting in increased imports. Demographic and income changes in the future are expected to lead to further rapid increases in demand requiring domestic production to increase more rapidly than has been experienced in the past. This will require adoption of improved technologies and management.

Among other things, credit has played an important role in rapid expansion of improved crop technologies in the developing countries. The literature on the relationship between credit and adoption of improved livestock technologies is scanty. Considering the potential role of credit in livestock development, a study was undertaken to assess the supply of and demand for livestock credit in selected sub-Saharan African (SSA) countries. The supply aspects were investigated in Ethiopia, Uganda and Nigeria using secondary data from major agricultural credit institutions in each country. The primary objective was to assess the extent of agricultural credit allocated to the livestock sector, access to such credit by smallholders, loan delivery terms and mechanisms and their effectiveness. The demand aspect was investigated in Ethiopia, Kenya and Uganda particularly focusing credit for improved dairy technologies because dairy is an important activity in all three countries, improved dairy technologies are already in use and further expansion of improved technologies are promoted through development projects often in association with credit. Intensive field studies were conducted on random samples of smallholder mixed crop-dairy farms over one year.

The supply side information revealed that livestock credit accounted for under 10% of total agricultural credit in the three countries and few smallholder livestock farmers had access to this credit because of the method and criteria used by credit institutions to screen applicants. For example, potential borrowers were required to show existing infrastructure for livestock operations before loan could be approved, or where collateral security was not demanded, credit worthiness of potential borrowers were determined by observable characteristics such as wealth or social standing. Both the conditions are unfavourable to smallholders. Most of the loan was for short-term, not always suitable for livestock enterprise, which requires longer period than crops to generate income and repayment capacity. Moreover, the credit institutions provided subsidised loans with grants or loans from the donors or the central bank of the country, so the available fund was limited requiring rationing. These credit institutions were not allowed to mobilise savings to generate funds.

The demand side information from the field studies revealed that all the sample farms used one or more component of improved dairy technologies such as crossbred cows, artificial insemination, improved forage and concentrate feeds, veterinary care. Less than 50% of the sample in Ethiopia and Kenya and nearly 80% in Uganda borrowed from formal credit institutions to purchase crossbred cows, some farmers spent a small part of the credit to purchase feeds, veterinary care, make barns or water supply systems for animals. Non-borrowers used own funds to purchase cows and other inputs.

The surveys also revealed that there were farms among both borrowers and non-borrowers who faced liquidity constraint to expand and operate their dairy operations; others did not have such problem. Respectively, 65%, 71% and 45% of the sample in Ethiopia, Kenya and Uganda were liquidity non-constrained, others were liquidity constrained. Results of a Probit regression model showed that in Ethiopia, liquidity constrained and non-constrained farms

were equally prevalent among borrowers and non-borrowers and they had significantly larger herd sizes and number of dairy cows. None of the other variables were significantly different between liquidity constrained and non-constrained farms. In Kenya, liquidity non-constrained farms were significantly more prevalent among non-borrowers and among female headed households. They also had more education but less livestock training, were older and used less labour compared to liquidity constrained farms. Other variables did not significantly differ between the two groups of farms. In Uganda, liquidity non-constrained farms were significantly more prevalent among non-borrowers, and they had larger farm size and used more labour compared to liquidity constrained farms. Thus it may be concluded that although some farms among both borrowers and non-borrowers faced liquidity constraint for their dairy operations, in two out of three countries non-borrowers were generally liquidity non-constrained. It is therefore possible that farms with different liquidity situations had different milk production functions.

Accurate assessments of farmers' liquidity constraint condition and its impact is important in order to understand the circumstances under which credit would have its greatest impact. In this study a switching regression model was used to determine the impact of liquidity and credit on smallholder dairy farms using farm level data from Ethiopia and Kenya. Farmers were classified as liquidity constrained or liquidity non-constrained based on their responses from the farm level surveys. No consistent relationship was found between farmers' liquidity constraint condition and their borrowing status. The number of crossbred milking cows in the dairy explained most of the variation in milk output per farm. Other variables, particularly use of variable inputs did not have significant effect in explaining productivity differences between groups of farms.

Since borrowers spent their borrowed funds mainly to acquire improved cows, the primary impact of credit was to increase milk production through increased dairy herd size. Borrowers and non-borrowers alike spent very little to better feed and manage the cows. Since smallholders' size of dairy enterprise will be limited to a great extent by the amount of crop and grazing land they hold, greater emphasis need to be given on the potential for increased milk yield through better feeding and management. Assuming that cash constraint was the primary reason for underspending on operational inputs and loosing good amount of potential milk yields, one can conclude that credit for operational expenses with or without credit to acquire cows has a great potential for contributing to increased milk production. The limited evidence on the positive interaction between liquidity and special livestock training indicate that where credit to overcome liquidity problem is combined with training in improved livestock management, the impact of credit on production is likely to be greater.

The results provided additional evidence on the importance of accurately assessing farmers' demand for credit. To do this policy makers and financial institutions need to go beyond classifying farmers as borrowers or non-borrowers, and take account of their resource endowments and household characteristics. An accurate assessment of farmers' liquidity constraint condition is important for credit policy because it will provide useful insights into the circumstances under which credit may have its greatest impact. The results of the supply side investigation also indicated that to give smallholders genuine access to formal credit, procedures for screening of applications that put smallholders at a disadvantage need to be rationalised. Duration of loan and repayment schedules should also match the income generating potential and cash flow of the enterprise for which loan is given. Subsidy on interest is not always productive, so the policy on interest rate should be based on the need for the credit institution to run economically and efficiently and the potential contribution that subsidised credit make to increase output, income and overall economic development.

Chapter 1 Background, objectives and organization of the study

M.A. Jabbar and Simeon K. Ehui

The livestock sector contributes substantially to the economies of Sub-Saharan African countries by providing food, income, employment and foreign exchange. In many countries in the region livestock also serves as a store of wealth and supplies inputs and services such as draught power, manure and transportation for crop production. The value of livestock commodities — meat, milk, eggs, wool, hides and skins — currently account for 28% of agricultural GDP (Williams *et al*., 1995). Livestock's share of agricultural GDP increases to about 35% when the value of non-monetized transactions such as animal traction, transport and manure are included. Livestock also contributes significantly to nutrition in SSA providing between 17 to 18% of the dietary protein in human diets (Winrock, 1992). Despite the importance of livestock in the economies of SSA, growth in output during the past decade has been below those in other developing regions. Between 1979–1981 and 1992, per capita production of livestock and livestock products declined by 14% in SSA. This compares to a 10% decline in West Asia and North Africa, zero growth rates in Latin America and the Caribbean and a 65% increase in Asia (Williams *et al*., 1995). In order to meet substantial deficits in the supply of meat and milk from domestic production in SSA, imports increased dramatically during the last three decades. These deficits are projected to increase in the future because of rising demand due to demographic changes and income growth as well as declining or stagnant supply. Growth rates in the livestock sector will have to increase significantly if future demands are to be met from domestic production. Higher growth rates will require, among other things, adoption of improved technologies and other inputs to increase livestock yields.

An important reason for the slow growth in domestic production is the low rate of adoption of available improved livestock technologies. In addition, there is little understanding of the impact of credit on the adoption of improved livestock technologies and on livestock production. Considering the multiplier income and employment effects of livestock development, an understanding of the linkage between credit and livestock technology adoption is expected to facilitate policy formulation for livestock development.

This study was conducted in two phases. In the first phase, the supply of credit to smallholder livestock producers by banking institutions in Uganda, Ethiopia and Nigeria was examined to test the following hypotheses: (a) relatively few smallholders have access to formal credit, and where credit is received, inconsistencies in loan structure and repayment conditions reduce the utility of credit. The principal objectives in the first phase were to: (a) assess the access to credit for smallholder livestock producers, and (b) examine the volume, type, purpose and conditions of livestock loans. Data were obtained from bank records and from bank officials' responses to a structured questionnaire.

In the second phase, the demand for credit by smallholder livestock farmers was examined. Intensive micro level field studies on samples of smallholder livestock producers were conducted in Ethiopia, Kenya, Uganda and Nigeria. The focus of the studies in Ethiopia, Kenya and Uganda was on smallholder dairy while in Nigeria the focus was on smallholder beef fattening. It was hypothesized that liquidity constraints limited the ability of many smallholder farmers to make investments in improved livestock technologies and purchase complementary inputs. The objectives of the study were to: (a) determine the extent to which improved livestock technologies were used by smallholder livestock farmers, and (b) assess

how liquidity constraints influenced herd structure, use of improved inputs and livestock.

Results of field studies from Nigeria, Ethiopia, Kenya and Uganda are presented in different chapters of this document. In chapter 2, the situation with respect to credit supply for the livestock sector is described. In Chapters 3 to 5, results of farm surveys respectively in Ethiopia, Kenya and Uganda on demand for credit and its utilisation are described. In Chapter 6, results of an econometric model to assess the impact of credit and liquidity on dairy production are described and their policy implications discussed.

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Chapter 2 Supply of institutional credit for smallholder livestock producers in Uganda, Ethiopia and Nigeria

H. Ade Freeman, Simeon K. Ehui and E. N. Betubiza

2.1 Introduction

The flow and impact of formal credit to the livestock sector has not been documented as well as for the crop sector in SSA. In particular, the flow of credit to smallholder livestock producers and the extent to which credit policies enhance the dissemination of livestock technologies is not well understood. This is a major gap in the literature considering the importance of livestock as sources of meat, milk, traction, manure, transport, cash income, and employment for large sections of the rural and urban populations in the region (Winrock, 1992).

This study focuses on the flow of formal credit to smallholder livestock producers. Formal credit is defined as credit given by financial institutions that have been legally established to engage in credit delivery and savings mobilization, including commercial and development banks and non-governmental organizations (NGO).[1] We focus on formal credit institutions because of the increasing recognition that they can play an important role in economic development (Heidhues, 1995). Credit is critical when the realization of income and expenditure occur at different points in time or when fixed capital is indivisible and requires outlays which cannot be divided into smaller payments. Also technological innovations may require increased outlays for working capital or investments in infrastructure which could be financed by formal credit. Though there have been many unsuccessful formal sector credit programmes and many doubts about the efficiency of smallholder credit programmes in developing countries, some successful cases also demonstrate that formal credit can be powerful instruments for economic development (Braverman and Guasch, 1986). Malik *et al*. (1991) showed that formal credit was positively correlated with the total value of agricultural output because it facilitated larger expenditures on modern inputs such as improved seeds and fertilizer. Using data from various countries in Asia, Latin America and Africa, Desai and Mellor (1993) showed that formal credit becomes increasingly important relative to informal credit as economies develop.

> 1. Other important source of credit is the informal credit market including traditional money lenders, traders, relatives, friends and mutual help associations. Livestock credit may be rarely obtained from these sources.

Subsidised credit is a common feature of formal credit programmes in developing countries. These programmes are frequently targeted to smallholder producers to compensate them for low, and often controlled, producer prices; to encourage adoption of new technologies, and

replace traditional moneylenders. In pursuit of these objectives governments, supported by bi-lateral and multi-lateral donors, have devised a myriad of institutional arrangements for delivering credit to rural areas. However, with few exceptions formal credit programmes in SSA have fallen substantially short of expectations (Von Pischke *et al*., 1983; Yaron, 1994). Recent literature suggests that credit subsidies have led to misallocation of resources, have typically not led to significant increases in adoption of new technologies, or have not succeeded in replacing traditional money lenders (Von Pischke *et al*., 1983; Winrock, 1992; Krause *et al*., 1990). There have also been problems with the credit institutions themselves. Despite substantial outlays, most of these institutions have experienced serious difficulties in loan recovery and have proved to be weak lending institutions over critical periods of food deficits.

The purpose of this paper is to assess the flow of formal credit to smallholder livestock producers in Uganda, Ethiopia, and Nigeria with a view to improving our understanding of the opportunities and constraints in formal livestock credit systems. The study is conducted at the level of financial institutions that deal mainly with smallholder livestock producers in these countries. These were the Uganda Commercial Bank (UCB), the Agricultural and Industrial Development Bank (AIDB) in Ethiopia, and the Nigerian Agricultural and Cooperative Bank (NACB). In each country, we selected branches of these banks located in a predominantly livestock area. Structured questionnaires were mailed to the selected banks. A senior bank official provided the necessary information from individual borrower records and other relevant bank documents. These included information on resource endowments of borrowers such as herd size, crop and grazing land, mechanisms of credit delivery, reported use of credit funds, and loan characteristics such as the amount of loan, interest charged, length of time before repayment started, duration of loans, repayment conditions, and collateral or other prerequisites for loan approval. The nature of credit schemes and the information kept by financial institutions on their clients in these countries differ in many respects. However, it is important to examine their similarities and differences because they could provide useful insights into critical issues that determine the flow of credit to smallholder livestock producers and the effectiveness of credit.

In section 2.2 we use data from the selected banks to examine credit delivery mechanisms, loan policies, use of loans, characteristics of borrowers, duration of loans. A review of the credit delivery system and analysis of loan policies, use of loans, loan beneficiaries, loan duration and repayment conditions in the selected countries follow this. The lessons learned from the review are then used to make suggestions that may make financial institutions more responsive to the credit needs of smallholder livestock producers.

2.2 Experiences with formal credit delivery in selected countries

2.2.1 Credit delivery mechanisms

Uganda: The most important source of formal credit for smallholder livestock farmers is the government-owned Uganda Commercial Bank (UCB), a multi-purpose bank providing loans to industry, transportation, commerce, and agriculture. The Rural Farmers Scheme (RFS), a specialized scheme for integrated rural development, is the primary channel in the UCB for lending to smallholders. Although RFS incorporates aspects of small-scale agro-industry, rural transport, and rural housing, most of the lending is for agricultural production. Loans and grants from the government and international donors support the RFS. Funds provided by the African Development Fund (ADF) carry a nominal service charge of 0.75% per annum while the remaining funds are granted by the Government to cover administrative costs.

The UCB has 10 regional offices and 185 branches. In 1992, the RFS engaged 22% of UCB's bank branches and 5% of its current staff. Potential borrowers are not required to provide

collateral as a precondition for loan approval but the local council should certify their credit worthiness. In addition, livestock producers have to provide evidence of prior experience with livestock husbandry and existence of some livestock-related infrastructure such as barns.

To avoid diversion of loan funds to non-approved activities, the RFS disburses most loans in kind and very little in cash. For example, over 90% of the livestock related loans disbursed in 1991/1992 were in the form of live animals or materials for fencing. The few cash loans given were mainly intended for payment of hired labour. Nominal interest rates charged to borrowers under the RFS were 37% and 32% per annum for unsecured and secured loans, respectively. These translated into real interest rates of –10.1 and –13.4%, respectively.[2]

2. Real interest rate was calculated using 1992 nominal interest rate and inflation rate figures. Inflation was calculated as the change in consumer price index. The formula used for the calculation was: {(1+r)/(1+i)-1}, where r is the nominal interest rate.

Ethiopia: The government-owned Agricultural and Industrial Development Bank (AIDB) is the principal source of agricultural credit including loans for livestock. The bank's mandate is to lend to private and public investors in the agricultural and industrial sectors. It provides short-term (1 year), medium-term (2–5 years) and long-term (over 5 years) credit. Its lending portfolio as of June 1992 was 77% to agriculture, 17% to industry and 6% to other sectors. It receives its funds directly from the state treasury and indirectly through specific lines of credit from external donors. It is not allowed to mobilize savings from the public. In 1992, AIDB accounted for 99% of the total volume of rural credit from the formal sector, the remaining 1% was disbursed by the Commercial Bank of Ethiopia (CBE).

Presently, AIDB has a network of 11 branches and 19 sub-branches. Its lending policies are directed by the central bank, the National Bank of Ethiopia (NBE) whose Board of Directors is also the governing board of AIDB. Lending policies have not always been dictated by commercial considerations. For example, as of June 1992 the bank had extended about 90% of its agricultural loan portfolio in unsecured loans to state farms and cooperatives. At the same time, state farms and cooperatives owed 97% of all delinquent loans.

During 1982–1992, agricultural loans constituted 62% of all approved loans by AIDB, and the smallholder sector accounted for only 9% of total rural loans (Tilahun, 1994). Of the agricultural loan portfolio, 94% was allocated to the crop sector and 6% to livestock. About 76% of livestock loans were allocated to government farms, 22% to service cooperatives and 1% each to producer cooperatives and private individuals.

The credit delivery mechanism of AIDB involved a two-tier system in which credit funds were advanced to service cooperatives for lending to farmers through their PAs. In principle, as the primary borrowers service cooperatives were responsible for determining their members' credit worthiness and ability to repay the loan. Service cooperatives were provided two types of incentives by AIDB to encourage vigorous loan collection. First, a service cooperative was allowed to generate revenues by adding upto 2% to the bank's basic 5% interest rate. Second, there was a threat that the service cooperative would receive fresh loans only when outstanding loans were fully paid by its borrowing members. The service cooperatives were expected to extend this requirement to the individual PAs as well. In recent years, government policy reforms have led to restructuring of the cooperative system. Almost all producer cooperatives have been dissolved while large numbers of service cooperatives are not functioning or are expected to be liquidated.

The NGOs such as the Finnish Development Aid Agency (FINNIDA) and the Canadian Physicians for Aid and Relief (CPAR) have also been important in smallholder livestock credit delivery. In most cases these loans were provided in kind except in a few operations where small cash loans were provided for beef fattening. AIDB branches usually administered these

loans on behalf of the NGOs. At the time of the survey, AIDB did not have any regular credit programme for livestock farmers except those provided by NGOs and ad hoc special projects.

Interest charged on loans is fixed by the central bank, NBE. Prior to 1992, the nominal interest rate on lending ranged between 5 and 7% per annum with preferential rates for state-owned enterprises and cooperatives. In 1992, as part of financial sector reforms, interest rates were increased to between 11 and 11.5% per annum and preferential rates were abolished. Lending rates have changed periodically since 1992. In September 1994, the lending rate on all types of loans was between 14–15% per annum. The real interest rate in 1992 was 0.9%.

Nigeria: The primary supplier of livestock credit is the Nigerian Agricultural and Cooperative Bank (NACB) established by the Federal Government in 1973 to provide agricultural loans to individual farmers, cooperatives, limited liability companies, state and federal government agencies. The NACB relies entirely on the government or donors for its funds. It does not mobilize any savings from its clients. As of January 1993, NACB had 9 departments, 5 zonal offices, over 50 branches and about 300 representatives throughout the country.

The NACB has two operational schemes for lending to smallholders. One is the smallholder direct loan scheme under which loans are mostly disbursed for crop production. Potential borrowers are not required to provide collateral security but they should provide evidence that they are full-time farmers, are resident in the village in which they have their farm and must provide two guarantors who should be persons of good standing in the community. The second scheme, specifically intended for livestock development, is the smallholder cattle fattening and work-oxen loan scheme. Loans can be used either to fatten mature cattle over a six-month period or to purchase a pair of work-oxen, complementary equipment, and other related inputs over a period of 3 years. Borrowers are required to procure all inputs, which are usually given in kind, from the National Livestock Projects Division. As with other NACB loans intended for smallholder producers, borrowers are not required to provide collateral security, rather they need to provide two guarantors who are persons of good standing and proven character in the community. NACB charged 15 and 17% nominal interest rates on its beef fattening and work oxen loans, respectively. These rates were below the 25% lending rate charged by commercial banks for similar activities. In real terms interest on NACB loans for beef fattening and work oxen were –20.5% and –19.1% respectively (Gefu, 1992).

2.2.2 Purpose of loan

In order to analyse the purposes for which loans were given, data on UCB loans disbursed in 1992, AIDB loans disbursed during 1985 – 89 and NACB loans disbursed in 1988/89 were available. Of all the livestock loans given by UCB in Uganda, 48% were given to finance the purchase of animals (15% for the purchase of exotic breeds and 33% for the purchase of local cross-breeds), 22% to finance the development of infrastructure e.g. fencing and water development, 14% for animal health inputs, and 16% for purchase of feeds and other inputs. The use of loan funds usually depended on the type of animals farmers kept, herd size and the size of grazing area. For example farmers keeping up to 10 crossbred cows spent 11% of loan funds on animal health; those with the same number of exotic cows spent almost double that amount on animal. This suggests that the adoption of exotic cows with higher milk productivity potential relied more on credit availability than crossbred herd operations.

In Ethiopia, 46 percent of livestock loans disbursed by AIDB were given for dairy enterprises including milk processing activities by state farms, 22% for beef fattening, 21% for animal traction and 10% for feed processing and 1% for dairy goats. The aggregate nature of the data did not allow us to clearly distinguish smallholders from other categories of borrowers. However, AIDB staff suggested that smallholders were given loans mainly to finance animal traction and beef fattening while state farms were given loans primarily for dairy operations.

About 78% of loans disbursed by NGOs were for the purchase of oxen, 22% for beef fattening enterprises, and less than 0.5% for dairy enterprises.

In Nigeria, of the total livestock loans disbursed by NACB 82% were given for beef fattening (purchase of cattle, supplementary feeds, veterinary drugs, and construction of barns), 8% for sheep fattening, 9% for poultry rearing, and 1% for animal traction.

2.2.3 Loan beneficiaries

In Uganda, only 13% of the total number of loans disbursed went to smallholders with less than 5 hectares of cultivable land, 17% went to owners of 5–10 hectares, 23% to owners of 10–20 hectares, 34% to owners of 20–50 hectares and 13% to owners of over 50 hectares. Average loan size was US$ 290 per borrower.[3] There were, however, large variations in loan size depending on the location of the borrower and the purpose of the loan. At branches near major urban centers such as Kampala, loans tended to be larger, averaging between US$ 359 and US$ 431 while average loan size for rural bank branches ranged between US$ 232 and US$ 314. A major reason for this disparity in loan size was that borrowers close to urban areas, such as Kampala, tended to purchase more exotic animals than rural borrowers. Exotic breeds were more expensive than local crossbreeds and they required larger outlays for veterinary care and feed.

3. At the time of the survey the official exchange rate was US$ 1 = Ush 1134.

In Ethiopia, farms are generally small due to egalitarian land distribution and the small number of loan recipients other than the state farms could be classified as smallholder livestock producers. Average farm size in three different locations (Selele, Nazreth and Debre Berhan) from where detailed records were collected ranged between 2.6 and 4.7 hectares while average herd size was between 5 and 6 cattle. Average loan size ranged between US$ 290 and US$ 580 for dairy loans, US$ 242 and US$ 611 for oxen loans, and US$ 169 for beef fattening loans.[4]

4. At the time of the survey, the official exchange rate was US$ 1 = EB 6.20.

In Nigeria, land is generally unequally distributed but in three different locations (Jos, Funtua and Kano) from where detailed records were collected, average farm size of loan beneficiaries ranged between 2 and 8 hectares while average herd size ranged between 3 and 16 cattle. Beef fattening loans were US$ 289 for first time borrowers with the amount rising to US$ 867 for borrowers with a proven credit worthiness rating. Maximum amount given for work bulls or equipment was US$ 867.[5]

5. At the time of the survey, the official exchange rate was US$ 1= N 17.30.

2.2.4 Duration and repayment of loans

The banks in Uganda and Nigeria tended to provide short-term loans to individuals and organized groups while the banks in Ethiopia mostly provided long-term loans. The majority of loans given by UCB in Uganda were for a fixed 18-month term regardless of the purpose of the loan. Repayments started after 6 months and the borrower was expected to pay the loan in full within this fixed term. In Ethiopia, loans for beef fattening were given for 5 years with the borrowers requiring making one repayment per year. Dairy loans were given for 5 years. Repayments started after one year and borrowers were expected to make equal annual repayments for the next 4 years. Oxen loans were given for 4 years with one payment required in each of those years. In Nigeria, NACB loans for beef fattening operations were given for a six-month period, to be repaid in one lump sum at the end of the period.

Loan recovery records in Uganda indicated an average recovery rate of 66% on livestock loans. In Ethiopia, AIDB could not provide up-to-date records on livestock loan recovery rates. However, aggregate loan recovery performance of the bank was poor. For example, as of June 1993, 89% of total outstanding loans were in arrears (Tilahun, 1994). Moreover, rates of defaults appeared to be increasing due, in part, to the dissolution of the service and producer cooperatives. In the absence of enforcement mechanisms for non-compliance, most cooperatives were dissolved without repaying their loans. In Nigeria, NACB reported steadily increasing loan recovery rates since the inception of the smallholder direct loan scheme. When the scheme started in 1988, loan recovery rate was at a dismal 2%. By 1992, average loan recovery rate had increased to 87% although there were wide variations in recovery rates by state. This steady improvement in NACB's loan recovery is partially due to its rigid loan collection policies which deny further loans to defaulters, compel guarantors to repay the loan in cases of non-compliance, and provides borrowers with prompt repayment record to re-apply for larger loans.

2.3 Major lessons

2.3.1 Allocation of credit

All the banks examined had as one of their objectives the increase in the flow of institutional credit to large numbers of smallholder livestock producers. To carry out this objective, the banks established specialized subsidized credit schemes and opened branches in rural areas. Despite these mechanisms, the findings of this study suggested that few smallholder livestock producers obtained formal credit in countries studied. Often, smallholder producers were screened out of formal credit markets because of the criteria banks used for loan approval. For example, UCB in Uganda required potential borrowers to show evidence of pre-existing infrastructure for keeping livestock before loans were approved, a condition unfavourable to smallholders. Indeed RFSs records showed that only 13% of livestock credit were allocated to farmers with less than 5 hectares of cultivable land. In Ethiopia, political rather than financial considerations motivated AIDB to allocate credit on concessionary terms to state farms and cooperatives despite their poor performance and high levels of loan delinquency. Allocation of bulk of credit to state farms and cooperatives meant that many smallholder producers did not have access to formal credit. In Nigeria and Uganda, banks did not insist on the provision of collateral security but they usually relied on the personal characteristics of potential borrowers to determine their credit worthiness. In cases where bank officials did not have sufficient information on a potential borrower they tended to allocate credit on the basis of observable characteristics of the borrower such as wealth or influence in the community. These factors screened out many smallholder borrowers about whom incomplete information was available.

Finally, the very tool used to expand credit to smallholders often prevented the neediest of these farmers from getting funds. Because credit was subsidized, demand tended to exceed supply, so it was rationed. Rationing rules often tended to favour influential community members who, for the most part, got larger loans. Since the size of the subsidy or income transfer increases with loan size, the larger producers received the largest income transfers. This means that current policies actually increased income inequalities between small and large borrowers.

2.3.2 Structure of loan terms and recovery

In Uganda and Nigeria, most of the loans were short-term with fixed repayment periods. Only in Ethiopia, AIDB had the majority of its portfolio in long term loans with repayment periods in more flexible than in Uganda and Nigeria. In theory, banks may opt for short-term loans because of the need to collect loans quickly, especially under conditions of high inflation and controlled interest rates, which can rapidly erode the real value of loan funds. Another reason

for short term loans might be the lack of collateral security provided by the borrower. On the other hand, some banks justify giving long-term loans on the ground that borrowers should be allowed to reinvest the proceeds from the loan in order to increase farm incomes and the ability to repay loan.

There is, *a priori*, no ideal loan term. What is important is to maintain flexibility by relating loan terms to factors such as the cash flow of the associated activity, availability and demand for inputs and risk. When these are not considered the consequences are likely to be inefficiencies in the use of capital, increased incentives for default on loan repayments, and increasing likelihood of screening smallholder producers from institutional credit markets. For example, under existing pricing and marketing arrangements, UCB's conditions on short-term loans in Uganda did not allow borrowers to generate sufficient revenues to repay loans within the stipulated period. Similarly, in Nigeria the short-term loans given by NACB for beef fattening was not consistent with the average fattening period of between 12–19 months. In both of these situations, smallholder producers had to seek additional funds from other sources to repay their loans. When this was not possible there was an increasing likelihood that producers would be forced to default or screened out of formal credit markets because the prospects of receiving future loans diminished. On the other hand, in Ethiopia the duration of most livestock loans ranged from 4–5 years with the borrower expected to make a single payment in each year. Ironically, this lengthy period provided incentives for borrowers to default on loan repayments particularly in the case of beef fattening and dairy loans where revenues from these activities were generated sooner than the permitted repayment period.

Subsidized credit programmes in Ethiopia have failed because of poor loan recovery. Service cooperatives were provided financial incentives for loan collection in addition to threats of possible denial of fresh loans in case of default by some of its members. Apparently these measures were not effective because AIDB records indicated that most of the loans were outstanding. The option of denying service cooperatives fresh loans without settlement of outstanding loans was not actually exercised since fresh loans were always given. Bank officials attributed the poor loan recovery rates, in part, to the lax attitude toward recovery and low level of supervision. Political motives which promoted cooperatives irrespective of their performance also contributed to low levels of loan recovery (Tilahun, 1994). In Nigeria, NACB's 85% recovery rate suggested that its mandatory collection policy which denied future loans to defaulters was effective. In some respects the bias towards relatively large borrowers contributed to high rates of loan recovery since these producers appeared to attach a high value to NACB's credit line (Aku, 1986). The UCB in Uganda reported recovery rates of 66% on livestock loans in 1990. This was partially attributed to the fact that the timing of loan repayments was consistent with the regular cash flow of dairy activities since farmers were paid weekly or bi-weekly by the Dairy Corporation, which are the major buyer and distributor of fresh milk in Uganda. Under these arrangements it was likely that farmers would have the cash available to make loan repayments on a regular basis.

2.3.3 Savings mobilisation

An important aspect of improving the supply of credit to rural clients is the development of true financial intermediaries that facilitate savings mobilizations and credit distribution (Desai and Mellor, 1993). The credit institutions examined in this study did not mobilize savings. They all relied completely on governments and foreign donors for loanable funds. In Ethiopia and Nigeria this was a result of deliberate government policy, which prohibited savings mobilization from the public. In addition, these institutions did not provide any other banking services to their clients other than distributing credit. Hence, they could not be regarded as true financial intermediaries that recognized the simultaneity of the demand for and supply of funds and the complementarities between increased finance and demand for new technologies.

2.4 Conclusions and policy implications

In many respects, the results from this study are consistent with those from the extensive literature on small farmer credit programmes in the crop sector in developing countries. For example, many smallholder credit programmes rely entirely on central governments or donors for funds and they do not emphasize savings mobilization. We also found that some policies and practices pursued by banks screened many smallholder producers out of formal credit markets, that many banks had inflexible loan term structures and persistent problems with loan recovery. Von Pischke et al. (1983), Braverman and Guasch (1986) and Adams (1995) reported similar findings.

This study suggests that if formal credit institutions are to carry out their mandate to provide credit for smallholder producers they should re-examine their delivery systems, loan policies and loan term structures. Institutions that provide subsidized credit should reconsider the necessity and effectiveness of subsidies on interest rates. It is important that interest rates are conducive to promote growth with equity, integrate financial markets, and improve the financial viability of the institutions themselves. In these respects, rates should be set to reflect, among other things, the expected rate of return on investment, macroeconomic conditions such as the normal rate of inflation, and the opportunity cost of capital.

Besides maintaining economically relevant interest rates, formal financial institutions should implement cost-saving measures that improve the timeliness of credit delivery, enhance risk sharing and reduce administrative costs. While loans in-kind reduce the possibility of credit diversion, it also reduces the efficiency of use of credit funds because producers are not given the opportunity to shop around from alternative sources. A better alternative is to turn over input distribution to private suppliers supported with credit. At the same time, they should improve screening, monitoring and supervisory capabilities to ensure that loans are used for their intended purposes.

If formal credit institutions are to adequately serve smallholder producers, governments should re-examine policies which prohibit banks from mobilizing savings. Formal credit institutions need to play an important role in mobilizing savings as they do in making loans available for investments. Savings mobilization is also critical for reducing interest rates and dependence on government and donor funds as well as for the development of viable financial institutions. For saving mobilization to be successful, financial institutions should be accessible with sufficient credit, the value of savings must be protected in real terms, financial services must be kept safe and related non-financial services must be available to the clientele.

There is an overriding need for formal credit institutions to re-examine the structure of loan terms to make them consistent with borrowers' ability to repay loans. The use of credit is more efficient when the structure of loan terms are tailored to meet the needs of clients. Loan duration and repayment conditions should be related to the size of the loan, the nature of the activity to be financed, and the cash flow pattern it generates, and risks considerations. Whereas short-term loans can be disadvantageous to the borrower, very long term can be equally disadvantageous to the financial viability of credit institutions.

This study was conducted at a time when many countries in SSA were undertaking financial reforms. The available evidence suggests that those reforms have had only limited success so far (World Bank, 1994). In particular, credit market reforms, where they have taken place, have been limited to the rationalization and liberalization of interest rates and elimination of preferential rates or directed credit (World Bank, 1994; Tilahun, 1994; Olomola, 1994). These partial reforms have eased repressions in financial markets but have had very little impact on other policies and practices regarding credit delivery, loan term structures, and savings mobilization (Adams, 1995; World Bank, 1994). The findings of this study also support these conclusions for the three countries studied. While policies that ease financial repression are

important components of a sustainable financial reform programme, other policies and practices that improve access to credit and enhance the pace of reforms are equally important if the desired results from reforms are to be achieved. Otherwise financial reforms will continue to have limited success which would generate further frustrations with reform programmes.

The demand for credit also depends on the availability of improved livestock technologies and the impact of credit on livestock production. The effectiveness of any credit programme may partly depend on legal and institutional environments in which formal credit institutions operate. These questions were not addressed in this paper but it is important to note that the formulation of sound credit policy needs to incorporate these factors.

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Chapter 3 Role of credit in the uptake and productivity of improved dairy technologies in Ethiopia

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3.1 Introduction

3.1.1 Background

Ethiopia has the largest livestock population in Africa. Current estimates put the livestock population at 29 million head of cattle, 22 million sheep, 17 million goats, 8 million equine, and 52 million poultry (FAO, 1993). The livestock sector plays a significant role in the domestic economy contributing about 15% of total GDP and 40% of agricultural GDP (Assefa, 1990; Winrock, 1992). Livestock exports (live animals and livestock products) accounted for 27% of the total value of merchandise exports and 34% of the total value of agricultural exports in 1992 (FAO, 1993).

The livestock sector provides draught power, meat and milk, cash income, and assets for many rural households. In some areas of the Ethiopian highlands, livestock production (including the value of home consumption but excluding draught power) accounts for over 50% of the total value of farm output and over 80% of farmers' cash incomes. Selling livestock helps maintain household food consumption during food shortages (Gryseels and Anderson, 1985). In the rangelands, livestock contributes over 90% of household cash income (Mekonnen *et al*., 1991). Investments in local livestock breeds have also been shown to generate attractive financial and economic rates of return (Itty *et al*., 1995)

Despite the large livestock population, livestock productivity in Ethiopia is below the average for most countries in eastern and sub-Saharan Africa. For example, the annual growth rate of beef and veal, and cow milk was 1.2 and 1.4% respectively for Ethiopia compared to 1.7 and 2.9% for eastern Africa[6] and 1.9 and 2.4% for SSA (FAO, 1995). Similarly, in 1994 average yield of beef and veal, and cow milk was 105 and 209 kg/animal respectively for Ethiopia compared to 123 and 350 kg/animal for eastern Africa and 140 and 376 kg/animal for SSA (FAO, 1995). The low level of livestock productivity in Ethiopia is also reflected in the relatively low levels of biological and milk production parameters. The national cattle herd is dominated by the small sized East African zebu with estimated average mature live weight of about 200 kg. On average, females produce their first calf between 37 and 48 months and calve every second year. Estimates of annual offtake rates range from 8 to 30% for cattle and between 18 and 25% for sheep and goats. Annual mortality rates are high ranging from 6 to 21% for cows older than 24 months, 21 to 48% for cows up to 12 months of age, and 11 to 16% for sheep

and goats, respectively (FAO, 1993; Itty *et al*., 1995). Average daily milk offtake per cow range from 1.5 to 2 litres over a 150 –180 day lactation period. About 0.3% of the national cattle herd are improved breeds which calve between 15 and 18 months give 6 and 10 litres of milk over a 270 – 300 day lactation period (FAO, 1993).

6. Eastern Africa includes Ethiopia, Kenya, Somalia, Uganda, Tanzania, Sudan and Djibouti.

Demographic changes and income growth is expected to increase future demand for dairy products rapidly (Winrock, 1992). Current growth rates are inadequate to meet rapidly rising future demand. Higher growth rates will require adoption of yield increasing technologies and inputs. For several years, the International Livestock Research Institute (ILRI), national research programmes and development organisations such as the Finnish aid agency FINNIDA, have promoted the use of improved dairy technologies — crossbred cows, complementary feed production, feeding strategies, and management. Many farmers are aware of the existence of improved dairy technologies and perceive them to offer higher returns than their current practices. Yet the intensity of adoption remains low. Improved dairy technologies require an initial investment and a recurring expenditure on feed and management, which are significantly higher than that required for traditional cattle ownership and management. Many farmers do not have the funds needed to make the initial investment and to buy the inputs associated with these technologies. These small scale farmers therefore cannot enjoy the benefits of using improved technologies and increase milk yields without access to credit to relax their liquidity constraints (Anteneh *et al*., 1988).

Rural credit in the country is channelled through formal sources such as banks, and informal sources such as relatives, friends and neighbours. The government-owned Agricultural and Industrial Development Bank (AIDB) provides most of the formal sector credit for agricultural and livestock activities (Tilahun, 1994). Non-governmental organisations (NGOs) have also been important sources of smallholder credit under various special agricultural development programmes. For example, the Finnish development agency FINNIDA provides credit for livestock development under the Selale Peasant Dairy Development Project. The total volume of credit channelled through various agencies to the dairy sector is rather small. Yet, these credit schemes provide an opportunity to test whether, among other things, binding liquidity constraints inhibit farmers from using improved dairy technologies or using them at sub-optimal levels, and whether credit helps to overcome the liquidity constraint.

3.1.2 Hypotheses and objectives

The purpose of this study was to test the following hypotheses relating to the use of improved dairy technologies and credit availability: (1) farmers use components of improved dairy technologies for increased milk production, (2) credit does not entirely overcome the liquidity constraint, (3) liquidity constraints limit the ability of farmers to acquire improved cows and/or regularly purchase inputs associated with improved dairy production, particularly (a) the proportion of crossbred cows in the cattle herd is larger for farmers without liquidity constraint and (b) farmers without liquidity constraint use higher levels of improved inputs, such as concentrates and veterinary drugs, and (4) milk yield (production per cow) is higher for liquidity non-constrained farmers.

The overall objective of the study was to assess the role of credit and liquidity on the uptake and productivity of improved dairy technologies. The specific objectives were to: (1) determine the extent to which improved technologies are used by smallholder dairy farmers, (2) determine if liquidity and credit influence the uptake of improved technologies, (3) determine the relative milk productivity of liquidity constrained versus liquidity non-constrained farmers given their resource and marketing conditions.

Primary data were collected by a survey of smallholder dairy producers in an area with a

history of dairy development and credit activities. In this study a smallholder dairy producer was defined as a producer with less than 10 dairy animals. Materials and methods for data collection are described in section 3.2 and the results of descriptive statistical analyses are presented in section 3.3. In section 3.4 the results are further discussed along with policy implications for livestock development.

3.2 Materials and methods

3.2.1 The study area

The study was conducted between November 1992 and April 1994 in Selale and Debre Libanos *Awrajas*[7] in Shoa administrative region, about 120 km from Addis Ababa. Highlands dominate this region with altitudes ranging from 2000 meters above sea level (masl) in Debre Libanos to about 3000 masl in Selale. The region has a bi-modal rainfall distribution with short rains (*belg*) occurring from February to May, and the long rains (*meher*) from June to September. The two growing periods corresponding to the rainfall distribution allow for a three-month cycle quick maturing crop planted in February or March and a three to six month cycle second crop planted in July. Crop cultivation during the short rains is more common at altitudes higher than 2500 masl. Seasonal variations in rainfall distribution patterns result in irregular supplies of good quality feed especially during the dry season when they are very limited. Hence, feed production strategies that ensure a steady flow of good quality feed are critical for maintaining high levels of animal nutrition throughout the year.

7. When this study was conducted, Awraja was the second level in the administrative hierarchy above the PAs. Since then *Awrajas* have been disbanded and replaced with a larger unit called *Woreda*

The predominant agricultural activity in this area is mixed crop-livestock farming. The main crops grown are *teff* (*Eragrostis teff*), wheat, barley, sorghum, chickpea, faba bean (*Vicia faba*) and some vegetables. Livestock provide households with milk, meat and traction.

This study site was selected because it was identified as a livestock production zone with a record of dairy development and credit activities. The Selale Peasant Dairy Development Project was started in this area in late 1987 to increase sustainable smallholder production by introducing crossbred dairy cattle into farming systems. The project aimed to realise this objective by distributing cross-bred cows, providing training on herd management, feeding and feed production strategies, and provision of animal health, veterinary services, and credit for livestock related activities.

3.2.2 Sample selection, classification and data collection

The sample was drawn from eight PAs where there were substantial numbers of dairy animals, both indigenous zebus and crosses between exotic Friesians and indigenous zebus. A two-stage sample selection procedure was used. First, a one-page questionnaire on herd inventory was administered to all the 2630 smallholder farmers in the eight PAs. Nearly all the farmers had a combination of local and crossbred cows. The pregnancy and lactation status of animals was noted. In the second stage farmers with animals in late pregnancy (7–9 months) or early lactation (1–3 months) were selected for the study because it was necessary to measure milk production. Given that an animal's stage of pregnancy or lactation status was a random event in a fairly homogeneous population, the two-stage sampling procedure adopted for the study resulted in the selection of a random sample of households and cows. By the end of the survey, 75 farmers provided complete information usable in analyses; 36 of them obtained credit from one or more sources, others did not borrow.

Structured questionnaires were used to collect data on the production and marketing behaviour of the sample households at daily, weekly, or monthly intervals over 67 weeks from November 1992 to April 1994. In the daily survey, information was collected on input use (both purchased and non-purchased), livestock-related expenditure, farm revenue, milk production for each cow, and milk disposal. General information on household demographic characteristics was recorded at the beginning and end of the survey. The objective was to record any changes in household composition over the survey period. Herd inventory was collected at three points during the year so that changes in herd structure during the survey period could be recorded. For farmers who obtained credit, information was collected on the source of the loan (formal or informal), the amount, purpose, loan conditions, procedures, and cost, any unsatisfied loan requirement and related reasons. For non-borrowers, the reason for non-borrowing was asked.

Information on borrowing status revealed that some non-borrowers did not borrow because they did not have liquidity problem while some non-borrowers had liquidity problem but did not have access to credit. Also some of the borrowers had unsatisfied credit need. Therefore, in addition to classifying farmers as borrowers and non-borrowers, they were also classified as liquidity constrained and liquidity non-constrained. [8] A farmers was considered liquidity constrained if: (1) he/she already had a loan but expressed willingness to borrow more at the current interest rate; or (2) he/she was unable to obtain loan because (a) the request for a loan was turned down, or, (b) there was no access to a formal or informal lender, or (c) no animals were available for purchase.

> 8. Feder *et al*. (1990) used a similar classification scheme but called them credit constrained and credit non-constrained. When a farmer has obtained credit but has unsatisfied credit need, he/she has a liquidity constraint rather than a credit constraint. Similarly a non-borrower needing money has a liquidity constraint.

Conceptually the classification used here gives a more accurate depiction of farmers' demand for credit than when a simple comparison of borrowing and non-borrowing is made. This is because a farmer, who did not borrow due to the availability of own funds to finance dairy activities, did not face credit as a binding constraint on production activities. Results will be presented by both borrowing and liquidity constraint status for comparison.

In order to relate credit and liquidity to technology uptake, information was collected on four broad categories of technology components related to improved dairy production: genetic, health, nutrition, and management. Genetic component included artificial insemination (AI) or the purchase of crossbred animals. Health component included the use of veterinary drugs and services. Nutritional component included the use of improved fodder and other livestock feed such as concentrates. Management component included improved herd management such as the construction of a barn or specific training that improves farmers' competence for decision making related to improved technologies.

Use of one or more of these technology components constituted an effort to raise milk yields. Because of interactions among different technology components, adoption of certain technology may influence the adoption of another in either positive or negative way. For example, a farmer with good management skills may not need large expenditures on veterinary services. Furthermore, technology adoption is a continuous process and farm households may be at different levels in the continuum of adoption and intensity of use of certain technologies. However, for the purpose of this study, technology adoption was characterised as a dichotomous variable with farmers classified as using either traditional or improved technology.

3.3 Results

The main findings from the survey are described in terms of types of farmers, household demographic characteristics, livestock and management, milk production, and disposal, household cash income, and share of dairy in cash income.

3.3.1 Types of farmers

The sample is roughly equally divided between borrowers and non-borrowers but 65% of the farmers were characterised as liquidity non-constrained and 35% as liquidity constrained (Table 3.1). The relationship between the borrowing status of farmers and their liquidity constraint condition was not statistically significant.

Table 3.1: *Distribution of sample farmers by borrowing and liquidity constraint status.*

	Borrowers		Non-Borrowers		Total	
	n	%	n	%	n	%
Liquidity constrained	11	31	15	38	26	35
Liquidity non-constrained	25	69	24	62	49	65
Total	36	100	39	100	75	100

Chi square between borrowing and constraint status of farmers = 0.53. Not significant at 5% level.

Thirty six out of 75 household heads, i.e. 48%, reported receiving credit from both formal and informal sources. Most of the borrowers received loans from banks although informal sources such as relatives and friends were also important (Table 3.2). Eight farmers had received loans from more than one source. Only 2 out of the 36 borrowers received loans in kind from informal sources, all others received cash loans. Development agencies and service cooperatives recommended most of the farmers receiving credit from banks.

Table 3.2. *Sources of loan by liquidity constraint status.*

	Liquidity constrained		Liquidity non-constrained		All	
Source of loan	n	%	n	%	n	%
Bank	5	33	23	79	28	64
Equb[a]	3	20	2	7	5	11
Friends/relatives	7	47	2	7	9	20
Other	–	–	2	7	2	5
Total	15	100	29	100	44	100

a. Mutual help association
The number of loans from the different sources (44) is greater than the number of farmers who borrowed (36) because 8 farmers borrowed from more than one source.

Over two-thirds of the borrowers from bank were classified as liquidity non-constrained while slightly less than one-third were liquidity constrained. Average size of bank loans received by liquidity non-constrained farmers was EB1151 compared to EB724 for liquidity constrained farmers. About 40% of liquidity constrained farmers reported that the amount of loan they received was less than what they requested for. Only 10% of liquidity non-constrained farmers reported receiving less money than they requested for.

Of those farmers who received credit from formal sources, 77% reported that the loans were used to purchase cows. Over 80% of these farmers were among those who were liquidity non-

constrained. Bank loans were usually long term. The average duration of these loans was over six years while the duration of loans from informal sources was less than three years. On average, farmers reported that the interest charged on bank loans was about 7% per annum. Most of the farmers (79%) reported that scheduled loan repayments were required for bank loans. Only 40% of the farmers who received bank loans reported making scheduled repayments. Of these, all liquidity constrained farmers and only 30% of liquidity non-constrained farmers were making scheduled repayments.

3.3.2 Demographic characteristics of households

Average family size was 7 people, with 53% female and 47% male. Ninety six percent of household heads were male. The average age of household heads was 46 years. The age distribution of the sample indicated a relatively young population with mean household age of 18 years. Family size and sex of household head did not significantly differ by borrowing or liquidity constraint status.

The adoption literature suggests that formal education is positively related to farmers' awareness of the economic advantages of improved technologies (Feder *et al*., 1985; Thirtle *et al*.,1987; Polson and Spencer, 1991; Hussain *et al*., 1994). In general, the level of education of the sample farmers was low. All female heads of households and 67% of male heads of households had no formal education. Remaining one-third of male household heads had primary or some high school education. A higher proportion of farmers without any formal education was liquidity constrained. However, no significant relationship was found between the level of farmers' education and their borrowing status or liquidity constraint condition.

Formal education may have very little effect on livestock skills, but other specific training and extension contacts can enhance farmer adoption and input allocation decisions. Over one-quarter of the household heads reported that they had attended some livestock training or seminar (Table 3.3). The majority of these were farmers who had received loans and were not liquidity constrained. Attendance at livestock training and seminars was significantly related to farmers' borrowing status but not to liquidity constraint condition.

Table 3.3. *Attendance at livestock training and seminar.*

	Borrowers		Non-borrowers		Total	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained		
	n	n	n	n	n	%
Yes	4	12	2	3	21	28
No	7	13	13	21	54	72
Total (n)	11	25	15	24	75	–
Total (%)	15	33	20	32	–	100

Chi-square between attendance at livestock training & seminar & borrowing status = 9.24,significant at 5% level. Chi-square between attendance at livestock training & seminar & constraint condition = 0.49, not significant at 5% level.

3.3.3 Livestock inventory and management

Average livestock holding of borrowers and non-borrowers did not differ significantly but liquidity constrained farmers had significantly smaller herds compared to liquidity non-constrained farmers (Table 3.4). Cattle, comprising over 75% of total TLU[9] across all farms, was the dominant species in the livestock herd. The composition of the cattle herd revealed that all farmers kept a relatively high proportion of mature females compared to other types of

cattle. Oxen were also important in the cattle herd because they provide traction power in the mixed crop-livestock farm system found in the survey area.

9. Tropical Livestock Unit is derived from the following ratios: mature cattle = 1 TLU, bulls 1 – 2 years = 0.80 TLU, heifers 1– 2 years =0.75 TLU, calves 6 months – 1 year =0.40 TLU, calves under 6 months = 0.20 TLU, sheep and goats = 0.10 TLU (ILCA, 1993).

Table 3.4. *Average livestock holding per farm (TLU) by liquidity and borrowing status.*

	Borrowers			
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
All cattle				
Local breed	9.41 (1.73)	12.99 (3.11)	8.35 (2.80)	11.88 (4.32)
Cross-bred	6.41 (2.25)	8.19 (3.87)	5.51 (2.74)	6.23 (3.13)
Dairy cows				
Local breed	0.91 (0.83)	1.88 (1.36)	0.93 (0.96)	1.29 (1.27)
Cross-bred	1.27 (0.65)	2.00 (0.91)	1.27 (0.46)	2.25 (1.22)
Equine	1.96 (1.40)	3.41 (1.82)	2.32 (1.14)	3.06 (1.56)
Small ruminants	0.59 (0.32)	0.98 (0.46)	0.56 (0.33)	0.86 (0.55)

Figures in parenthesis are standard deviations.

On average, farmers kept between 8 and 13 cattle per farm, of which between 6 and 8 were local breeds and 2 to 6 were crossbred cows. All categories of farmers held more locals than crossbred cows per farm irrespective of their borrowing or liquidity constraint status. Liquidity non-constrained farmers kept significantly larger ($p<0.05$) numbers of cattle and cross-bred cows per farm than liquidity constrained farmers. Farmers kept, on average, 2–4 milking cows per farm with twice as many crossbreds as local breed cows. Among all farmers, liquidity non-constrained ones kept a significantly larger ($p<0.05$) number of milking cows per farm than those who were liquidity constrained. The borrowing status of farmers did not significantly affect the average number of milking cows held per farm.

A key research question was to ascertain whether farmers were actually aware of the existence of improved livestock technologies and were using them. The survey results permitted us to clearly determine farmer use of improved genetic (crossbred cows) and nutritional (improved feed) technologies. All the farmers reported keeping at least one cross-bred animal, all farmers used grass hay, 92% used green oats, 28% used oats and vetch hay, 59% used oat seed and 44% used noug cake.

Natural grazing on communal pastures provided most of the livestock feed but supplementation with different forages and concentrates were also important. Overall, forages were the most important supplements constituting 93% of the total dry matter of supplementary feed recorded during the survey period remaining 7% were concentrates. Among borrowers, liquidity-constrained farmers fed relatively more concentrates per cow than liquidity non-constrained farmers did; the opposite was the case among non-borrowers. Liquidity non-constrained farmers fed relatively more forages per cow irrespective of the their borrowing status (Table 3.5). However, none of these differences were statistically significant.

Table 3.5. *Average quantities of supplementary feeds consumed (kg/animal), 1992/93.*

Feed type	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Concentrate	0.87 (2.90)	0.53 (1.77)	0.49 (1.32)	0.55 (2.40)
Forages	4.65 (3.03)	7.14 (7.19)	5.63 (5.96)	6.68 (8.68)

Figures in parenthesis are standard deviations

Grass hay was the most important forage used accounting for over half of the total forage fed to cows (Table 3.6). All farmers fed grass hay and cereal straw to their cows and over 90% fed green oats. Less than a third of the surveyed farmers used cultivated fodder such as oats and vetch hay, as forage. Concentrates were relatively less important as supplementary feed constituting only 7% of total dry matter of supplementary feed consumed over the survey period. Over one half of the sample farmers reported feeding concentrates in the form of oat seed and some type bran, while slightly less than one half used noug cake. Oat seed was the most important types of concentrate used by liquidity constrained farmers and noug cake by liquidity non-constrained farmers (Table 3.7).

Table 3.6. *Share of different forages consumed (% of kg DM), 1992/93.*

Forage types	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
	%	%	%	%
Grass hay	57	50	40	54
Oats hay	2	1	n	n
Oats and vetch hay	n	-	n	n
Green oats	17	35	38	29
Teff straw	6	2	3	3
Wheat straw	3	2	n	2
Barley straw	3	4	4	3
Other straw	4	3	15	2
Tagasaste	–	n	n	n
Other forages	6	4	n	6
Total	100	100	100	100

n = negligible i.e. less than 0.5%.

Table 3.7. *Share of different concentrates consumed (% of DM kg), 1992/93.*

Type of concentrate	Borrowers		Non-borrowers	
	Liquidity constrained %	Liquidity non-constrained %	Liquidity constrained %	Liquidity non-constrained %
Oat seed	41	29	63	26

Whole seed barley	n	n	n	1
Barley bran	11	4	14	9
Wheat bran	6	n	2	1
Noug cake	22	57	12	54
Cotton seed	n	–	–	–
Cotton seed cake	–	n	–	n
Mineral salt	–	2	–	n
Local salt	4	5	4	7
Other concentrates	15	2	6	3
Total	100	100	100	100

n = negligible i.e. less than 0.5%.

The survey also revealed the greater feed requirements of crossbred compared to local cows. Overall, crossbred cows consumed about 80% of the total quantity of supplementary feed (forages and concentrates) in terms of dry matter during the survey although they accounted for only about one-third of the total cattle TLUs.

Family labour accounted for 92% of labour use and herding accounted for the bulk of it (Table 3.8). About 90% of meagre hired labour were used for herding. There was a clear gender division in the distribution of labour hours by activity. Adult males provided about 80% of total labour for feeding cows, artificial insemination, disease control while females provided over 75 and about 95% of total labour for milking cows and making butter, respectively. Children, especially boys between ages 7 and 14, provided over 50% of total labour allocated to herding, the remainder was provided by adult males.

Table 3.8. *Proportion of total labour hours spent in various activities.*

	Borrowers		Non-borrowers		
Type of activity	Liquidity constrained %	Liquidity Non-constrained %	Liquidity Constrained %	Liquidity Non-constrained %	All farmers %
Feeding cows	6	4	5	5	5
Milking cows	1	3	2	3	3
Deliver milk	1	3	1	3	3
Making butter	4	3	3	4	3
Cleaning etc	5	8	7	8	8
Herding	82	79	80	75	78
Others	1	1	1	1	1
All activities	100	100	100	100	100

3.3.4 Milk production and disposal

On average, crossbred cows gave significantly higher ($p<0.05$) milk yield per day than local cows (3.40 ± 1.65 litres versus 1.47 ± 0.58 litres). Average lactation period was 298 days for crossbred and 189 days for local cows. However, the farmers' borrowing status or liquidity constraint condition did not have any significant effect on the average daily milk yield of crossbred and local cows although milk yield of borrowers was generally higher than non-borrowers. Estimated coefficients of variation (CV) were 49% for crossbred and 39% for local cows (Table 3.9). This indicated wide variation in average daily milk yield for both breed types.

Of all the completed lactations of crossbred cows, about 37% recorded average daily milk below 2 litres and over 50% recorded between 2 and 6 litres. On the other hand, of all the completed lactations of local cows, the corresponding proportions were 80 and 16%.

Table 3.9. *Daily milk yield per cow (litres) by breed and farmers' borrowing and liquidity status.*

Breed of cow	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained	All farms
Cross-bred	3.51 (1.51)	3.66 (1.59)	2.94 (1.48)	3.38 (1.90)	3.40 (1.65)
Local breed	1.77 (0.78)	1.53 (0.65)	1.37 (0.43)	1.30 (0.40)	1.47 (0.58)
All	2.84 (1.02)	2.96 (1.12)	2.49 (1.16)	2.86 (1.42)	2.65 (1.23)

Figures in parenthesis are standard deviations.

Average quantity of milk disposed through different channels and the proportion of the total quantity of milk disposed through various outlets during the survey is shown in Table 3.10. The single most important form of disposal was to convert milk into butter for consumption and sale. Among borrowers, liquidity constrained farmers converted more milk into butter while liquidity non-constrained farmers sold more fresh milk. Among non-borrowers there was no such difference. The most important outlet for fresh milk sales was the milk collection centres of the government owned Dairy Development Enterprise (DDE), followed by direct sales to individuals and other private institutions.

Table 3.10. *Daily milk disposal per farm (litres) by borrowing and liquidity status.*

	Borrowers		Borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Feed to calves	0.19 (5)	0.51 (8)	0.01 (-)	0.16 (3)
Consumed fresh	0.46 (12)	0.43 (7)	0.46 (13)	0.64 (12)
Converted to butter	2.71 (70)	2.92 (45)	2.01 (56)	2.88 (52)
Sold	0.52 (13)	2.62 (40)	1.11 (31)	1.79 (33)
Total	3.88 (100)	6.48 (100)	3.59 (100)	5.47 (100)

Figures in parenthesis are percentages.

3.3.5 Farm cash income and share of milk

Income from the sale of dairy products provided 34–35% of household cash income for liquidity constrained farmers compared to 50–54% for liquidity non-constrained farmers (Table 3.11). The higher share of non-constrained farmers resulted from higher share of fresh milk sales. When income from dairy products was combined with income from the sale of livestock and other livestock products, income from livestock sources accounted for 70 – 90% of household cash income. The other important source of household cash income was crop sales, particularly among borrowers who were liquidity constrained. Neither farmers' borrowing status nor constraint condition had a significant effect ($p > 0.05$) on cash income from different

sources.

Table 3.11. *Sources of household cash income (EB/farm).*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Sources of income	EB	%	EB	%	EB	%	EB	%
Sale of milk	2385	7	27652	35	6219	18	18115	25
Sale of cheese	4760	13	5632	7	2131	6	6349	9
Sale of butter	5288	15	9588	12	3488	10	11662	16
Total dairy products	12433	35	42872	54	11838	34	36126	50
Sale of livestock and other livestock products	12381	34	26525	34	14528	42	28484	40
Crop sales	10684	30	7587	10	4428	13	4390	6
Feed sales	520	1	1043	1	2637	8	807	1
Off-farm	139	1	–	–	1000	3	1901	3
Total	36157	100	78027	100	34431	100	71,708	100

Note: Percentages may not add up to 100 due to rounding.

Average cost of variable inputs per TLU and its distribution are shown in Table 3.12. The cost of feeds accounted for the largest proportion of total cost of purchased inputs with expenditure on forages being relatively more important than expenditure on concentrates for all categories of farmers. Expenditure on veterinary services was less important; accounting for less than one-fifth of total variable input cost for all farmers. Among borrowers, liquidity constrained farmers reported larger average expenditures on concentrates and forages per TLU than liquidity non-constrained farmers did. Among non-borrowers, liquidity constrained and liquidity non-constrained farmers reported roughly equal average expenditures per TLU on concentrates but liquidity non-constrained farmers reported larger expenditures per TLU on forages. Farmers' borrowing status did not account for any significant difference in average expenditure per TLU for any of the input categories but their constraint condition was significant in explaining variations in expenditure per TLU on forages.

Table 3.12. *Average input cost (EB/TLU) by borrowing and liquidity status.*

	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Concentrate feeds	10.10 (24)	8.26 (41)	4.43 (27)	4.41 (35)
Forages	16.65 (38)	9.31 (42)	11.95 (62)	5.19 (41)
Veterinary drugs and services	7.45 (16)	3.90 (16)	2.44 (9)	4.11 (16)
Other inputs	17.05 (22)	2.31 (1)	6.21 (2)	25.05 (9)

Figures in parenthesis are percentages.

Subtracting the dairy revenue per TLU from input cost per TLU yielded a measure of gross margin per TLU. These results gave an indication of the profitability of dairy activities (Table 3.13). Since the opportunity cost of household labour and other resources is low, the positive

gross margins per TLU for all farmer categories indicated that dairy activities were, in general, profitable. Gross margins per TLU were higher for liquidity non-constrained farmers irrespective of their borrowing status because liquidity non-constrained farmers earned more than twice as much income from dairy activities compared to liquidity constrained farmers but the levels of variable expenditure was roughly similar among all farmer categories.

Table 3.13. *Gross margin per dairy herd (EB) by borrowing and liquidity status.*

Income and expenses	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Dairy income				
Sale of milk	100	279	215	206
Sale of cheese	54	48	28	57
Sale of butter	450	102	194	127
Value of milk consumed fresh	83	57	82	84
Value of milk fed to calves	62	58	2	18
Total (a)	749	544	521	492
Operating expenses				
Cost of concentrates	51	33	26	14
Cost of forages	88	63	98	32
Expenditure on veterinary services	32	13	14	16
Expenditure on other inputs	139	27	33	32
Cost of hired labour	19	23	3	22
Total expenses (b)	329	159	174	116
Gross margin (a – b)	420	385	347	376

3.4 Discussion and policy implications

3.4.1 Discussion of results

The survey results indicated that there were liquidity-constrained and liquidity non-constrained farmers among both borrowers and non-borrowers indicating the fact that borrower versus non-borrower distinction is not adequate to determine the role of credit in farmers' decision making. It also suggests that disequilibrium exist in credit transactions at the household level. Thus both excess demand for or excess supply of credit are possible within borrowing and non-borrowing households such that the marginal productivity of credit would be different even within groups of borrowers and non-borrowers.

The survey results support the hypothesis that many smallholder farmers are aware of and use one or more improved dairy technologies. However, the intensity of adoption remains low. The results are consistent with previous research results which showed that, in general, cross-bred cows constituted a smaller proportion of dairy herds among smallholders in Ethiopia, and improved feed constituted a relatively small proportion of total feeds used (DDE, 1994; ILCA, 1991). Anecdotal evidence and results from previous research suggest that the smaller proportion of cross-bred cows in the total dairy herd reflects, among other things, one aspect of farmers risk management strategies. Farmers keep fewer cross-bred than local cows because crossbred cows are more susceptible to environmental stress, such as diseases, than the local breeds. Hence, farmers trade off the potential income gains from higher milk yields from crossbred cows against the risk of increased health costs or losses associated with

these animals.

Sometimes questions are raised about the economic viability of crossbred cows on-farm under current management practices and milk pricing policies. The results showed that while crossbred cows produced twice as much milk as local cows they also consumed four times as much supplementary feed as local cows.

The composition of supplementary feed shows that forages are used more frequently and in larger quantities than concentrates. Among the different types of forages, grass hay is used most frequently. The use of sown forages such as oats and vetch as green fodder is marginal. For the most part, this can be attributed to shortage of land for cultivating fodder. The low intensity of concentrate use explains the lack variation in milk yield and is therefore a serious constraint to milk production on smallholder farms (Barry Shapiro, personal communication). Results from previous research suggest that its irregular supply and higher price explain the low intensity of concentrate use. For example, in a recent survey by the DDE (1994), farmers in peri-urban areas in Ethiopia ranked the irregular supplies and high price of concentrates as the two most important constraints to their use.

The higher milk yield of cross-bred over local cows confirm results of earlier field studies though the average milk yields found in this study are lower than those reported earlier. For example, O'Connor (1990) in a study of 160 smallholder dairy farmers around Debre Zeit, within a 50 mile radius from Addis Ababa, reported average daily milk yield of 2 litres for local cows and 6 litres for cross-bred cows. The DDE (1994) survey, which included 281 peri-urban dairy producers up to 150 miles from Addis Ababa, reported average daily milk yields of 2.3 litres for local cows and 6.2 litres for crossbred cows.

The finding that the bulk of the credit was used to purchase cross-bred cows and that borrowing farmers with liquidity constraint had significantly larger cattle herds than non-borrowing farmers suggests that credit was used mainly for acquiring cattle. Very little credit was used for the purchase of variable inputs such as improved feed or veterinary services. While the adoption of these component technologies are closely related to the investment decision in cross-bred cows, the lack of credit for the purchase of variable inputs is an important constraint to increase yields and ultimately the profitability of investments in improved dairy technologies.

The analysis of milk disposal patterns showed that all farmers converted large quantities of milk into butter and most sold liquid milk to the DDE at controlled prices that are considerably lower than open-market prices. Studies by O'Connor (1992) and DDE (1994) reported similar findings. In the absence of adequate storage facilities, converting milk into butter increases its shelf life and adds value. For example, in 1992 the producer price per litre of milk paid by DDE was about 50% of consumer prices in Addis Ababa whereas producer prices for a kilogram of butter in rural markets was 80% of consumer prices in Addis Ababa (DDE, 1994).

The survey results suggest that farmers' liquidity constraint status is a significant consideration in explaining the difference in performance between different types of farmers. For the most part, liquidity non-constrained farmers performed better than liquidity constrained farmers. They held relatively more cross-bred cows in the total cattle herd as milking cows, used relatively more improved inputs, and produced relatively more milk per farm than liquidity constrained farmers' irrespective of their borrowing status.

3.4.2 Policy implications

One clear implication from this study is that improving access to adequate credit to farmers whose activities are constrained by liquidity will accelerate the uptake of dairy technologies in Ethiopia. Aggregate output in the dairy sector would increase substantially if liquidity

constrained farmers could raise their levels of investment and variable input use to those achieved by liquidity non-constrained farmers.

In the context of credit policy there is a need to draw clear distinction between credit used as investment capital such as the purchase of a cow, and credit used for working capital such as expenditure on improved feed or veterinary services. Our results indicated that nearly the entire amount of credit was used for acquiring dairy cows with very little going towards their proper feeding and management. This explains, in part, the low intensity of use of improved feed and veterinary services among all farmer categories in the survey. Moreover, given the high incidence of livestock diseases and its negative impact on dairy herds in Ethiopia, credit facilities for smallholder producers can help smooth consumption and, therefore, encourage risk averse producers to invest in improved dairy technologies.

In addition to technology and credit policy, output and input price and marketing policies are important to provide incentive for adoption of improved technologies. Controlled prices and monopolistic marketing arrangements result in reduced income and welfare losses for many farmers. Supply constraints on improved production inputs create disincentives for farmer adoption and reduces the effective demand for production credit. These factors reduce the potential profitability of improved dairy technologies and inhibit the pace of their adoption.

Aggregate output in the dairy sector can also be increased through interventions that increase the intensity of improved technology and input use among liquidity non-constrained farmers. Such interventions include education and extension efforts to enhance farmers awareness of alternative storage and processing technologies as well as their management skills. Investments in public goods and support services that reduce the perceived riskiness of using crossbred cows and associated variable inputs would increase farmers incentive to intensify the adoption of improved dairy technologies.

When liquidity is a binding constraint to dairy activities, the amount and combinations of inputs used by a farmer deviate from the levels that would have been utilised if credit were not a binding constraint. Liquidity constrained farmers are likely to be less productively efficient than liquidity non-constrained farmers are. The marginal effect of credit is, therefore, to bring input levels closer to the optimal levels without liquidity constraint, thereby increasing milk yields and hence aggregate output. Given the large numbers of smallholder dairy farmers, widespread use of improved dairy technologies supported by credit has major social welfare implications including improvements in household food security and employment. From a resource management perspective, higher milk yields obtainable from improved technologies would provide incentives for not holding large herds of less productive local breeds, which would reduce the pressures on feed resources and the environment.

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Chapter 4 Role of credit in the uptake and productivity of improved dairy technologies in Kenya

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10. The authors are grateful to Drs. Simeon Ehui, H. Ade Freeman and E Betubiza for financial and research support, and to Daniel Chege, Osano Rute and Michael Ngugi for research assistance.

4.1 Introduction

4.1.1 Background

Dairy production plays a significant role in Kenya's economy. The country is generally self-sufficient in milk and milk products except during extreme drought years such as the periods 1979/80–1986/87 and 1992 (Govt. of Kenya, 1993). Occasionally, small quantities of dairy products have been exported to generate some foreign exchange. Due to the rapidly rising population growth (about 3.2 % per annum) and possible general increase in per capita income, maintaining self-sufficiency will be difficult if efficiency in production, processing and marketing is not improved. On the supply side, the dairy enterprise will have to compete with other farm enterprises for the diminishing available arable land.

The overall objective of the government in the dairy sector is stated to be that of increasing productivity and conserving the scarce land resources. The government aims at maintaining self-sufficiency since it is believed the country has comparative advantage in milk production within the East Africa region. Productivity increases are expected to be achieved through policies facilitating access to appropriate production technologies and inputs. Processing and marketing system objectives are to be achieved through policies facilitating competition, efficiency and self-sustaining systems (Govt. of Kenya, 1993).

The dairy sector is dichotomous in the sense that smallholders produce over 65 per cent of the marketed milk, large-scale farmers produce the remainder. The production is concentrated in the high and medium potential agro-ecological areas of Kenya, comprising about 2.8 million hectares. The recently published Dairy Policy Paper indicates that cattle milk production averages about 1.8 billion litres per year of which about 70 % comes from exotic crosses or imported cattle estimated at 0.9 million lactating cows (each giving about 1400 litres of milk per year) while the balance is produced by Zebu cows numbering about 2.9 million, each producing 200 litres of milk per year (Govt. of Kenya, 1993).

The potential for increasing marketable domestic milk production lies mainly in improving the technologies used at the smallholder farm sector. The other area of concern to complement

technology improvement would be to strengthen dairy input and output marketing systems as has been shown by studies such as that of Mbogo (1992).

The motivation for the current study arose from the observation of research institutions such as Kenya Agricultural Research Institute (KARI), agricultural universities and the International Livestock Research Institute (ILRI) have developed dairy technologies to improve milk yields yet dairy farmers seem to be relatively slow in adopting the technologies. Farmers in the high potential agro-ecological zones of Kenya appear to be adopting exotic and crossbred dairy animals. Smallholders, however, are generally still inclined to increasing the herd size of Zebu animals which often leads to overgrazing and consequently to reduced animal productivity and environmental degradation in some pockets of these high potential areas and most of the medium to low potential areas. There is an urgent need for increased intensification of dairy production through the use of technologies that have been shown by researchers to enhance productivity. The technologies include those requiring genetic, feeding and health interventions as well as other animal management interventions such as housing.

Poor adoption of technology may be due to one or more of the following factors: (a) lack of capital to acquire and apply the technology; (b) inappropriateness of the technology to the users, given the farming system; (c) poor extension effort to propagate the technology leading to lack of awareness by the potential users; (d) economic factors which may be associated with the relatively high cost of technology compared to the perceived returns from its application; (e) sociocultural reasons associated with its incompatibility with existing norms and values of the society; (f) poor input and output marketing system, and (g) riskiness or perceived riskiness of a new technology.

In the dairy farming systems in Kenya there are farmers who know about the various dairy technologies and who perceive their proper application to be generally associated with greater benefits than costs and thus deem them appropriate for their farming operation. If such farmers lack the capital to acquire and sustain the use of technologies they will be constrained in improving milk yield. Without external sources of fund, the majority of such smallholder dairy producers would not be able to generate adequate funds from their own sources to reap the full benefits of available improved dairy technologies. This study therefore singled out credit as a factor meriting examination with a view to understanding its role in the uptake of available dairy technologies in Kenya. The input and output marketing, which have been largely controlled by the government in the past, are currently liberalised with the hope that the marketing constraints to improved milk production will eventually be eliminated.

4.1.2 The objectives of the study

The overall objective of the study was to examine the role of credit in the uptake and continuous use of dairy technology by smallholders in Kenya. The study was expected to provide insights and understanding to enable effective policy formulation aimed at determining the association of credit availability and use of dairy technologies in a typically smallholder dairy farming area in Kenya. The other objective was to assess the relative productivity of liquidity constrained and non-constrained farmers.

The following were some of the research questions: (a) are the farmers actually aware of the existing technologies? (b) why do some farmers borrow while others do not borrow? (c) are there farmers who desire credit but cannot get it? do borrowers have unsatisfied credit need? Is credit a constraint to technology adoption? (d) if credit is obtained, what are the source, purpose and loan condition and the procedure for accessing and paying back the loan? (e) do liquidity constrained farmers use available technology and consequently achieve higher productivity compared to liquidity constrained farmers?

It was hypothesised that when investible funds are raised either from own sources or through

borrowing from formal and/or informal sources, the producer will be able to acquire the technology (pay the initial investment cost) and have access to and readily purchase inputs and services associated with the new technology. The use of the technology will then raise dairy productivity measured in terms of milk output per animal (yield) and lead to high net return to the producer. The return thus generated could be used to build up own funds for future re-investment and/or servicing of the loan and facilitate continued use of the technology, higher dairy productivity and consequently improved family welfare.

4.2 Methodology

4.2.1 Sampling and data collection

The study was conducted in Kiambu District, a high potential agricultural area where smallholder dairy production is a major activity. The district is located in a peri-urban area close to Nairobi where the demand for milk will continue to increase giving the farmers an opportunity to produce more milk. Credit activities are also known to exist in the district. The district's proximity to the University of Nairobi also provided a logistical advantage in terms of supervising data collection.

Two divisions (Githunguri and Limuru) within Kiambu District were identified following discussions with the District Livestock Development Officers.[11] Within each division, two sub-locations were selected purposively. In Githunguri Division, Giathieko and Ikinu sub-locations were selected while in Limuru Division, Kabuku and Kamirithu sub-locations were selected. Then a three step sampling procedure was followed to select farms. A preliminary survey involved a census of all 1225 livestock farmers in all the sub-locations selected for the study. This reconnaissance survey recorded whether: (a) the farmer had at least a cow at late pregnancy (8 or 9 months in-calf); (b) within the herd, at least one cow had been in lactation for not more than 3 months; and (c) the farmer had obtained any credit from any source.

11. Kenya is divided administratively into provinces which are further divided into districts, divisions, locations and sub-locations respectively.

These conditions were used as a basis for selecting sample for detailed survey because the data on daily milk production from the animals was to be collected for about one year from the inception of the survey. It turned out that, all livestock producers had at least a cow but not necessarily pregnant or in lactation. Therefore, out of the 1225 farmers, who constituted the population, only 232 were eligible for detailed study. Of these, 80 borrowed money from one or more sources, 152 did not borrow.

From the 232 eligible farmers, 96 farmers, i.e. 24 farmers from each sub-location, were randomly selected for the one-year intensive monitoring. Since there were fewer borrowers than non-borrowers, borrower farmers were given higher weight in selection to ensure adequate representation. Two of the borrowers refused to cooperate. Others indicated they had not benefited from any credit after the survey had started, therefore these farmers were subsequently placed in the non-borrower category. Of the initial 96 farmers selected, 14 had to be replaced within the first one month of the study: 6 for lack of cooperation, 2 for sale or death of animals, 5 for animals not in lactation, and 1 for out migration.

Sixteen enumerators were recruited to collect the information. Each enumerator was expected to cover about 7 farmers, collecting daily records on activities associated with the dairy enterprise using the structured and pretested questionnaire. By the end of the survey, a total of 94 farmers provided complete information suitable for analysis. Data were collected on household characteristics, herd characteristics and management, land tenure, inputs, outputs and costs, credit and its use.

4.2.2 Characterisation of farmers

From information on credit, it was apparent that some farmers did not borrow perhaps because they had their own funds to finance dairy operations. Some borrowers also needed more funds. So categorising farmers into liquidity constrained and non- constrained groups was considered useful to compare how they affected the extent of adoption of dairy technology as well as performance in dairy production.[12]

12. Feder *et al* (1990) made a distinction between credit-constrained and non-constrained farmers in the same way as we propose to distinguish liquidity constrained and non-constrained farmers.

A household was considered facing liquidity constraint if: (a) it already borrowed and yet expressed willingness to borrow more at current interest rates but could not obtain the loan; (b)

it did not borrow but reported inability to obtain credit due to one or more of the following reasons: (I) request for a loan was turned down, (ii) had no access to formal or informal lender, (iii) no animal may be available for purchase using credit funds meant for the purpose.

Three broad categories of technology components were identified that are pertinent to improved dairy production: genetic, health and nutrition. The genetic component includes artificial insemination, crossbreeding or purchase of pure or crossbred animals. The health component includes use of veterinary drugs and services while the nutritional component includes use of improved fodder and other livestock feeds such as concentrates. Adoption of one or more of these technological components constitutes an effort to raise milk yield.

It was recognised that technology adoption was a continuous phenomenon and households might be at different levels in the adoption spectrum and intensity (low, medium and high) of adoption of a given technology. Similarly, there was bound to be interaction effects of use of particular aspects of the technology components on productivity. Given the nature of the data obtained from farms and for purposes of clarity, a dichotomous classification of technology was adopted. Farmers were considered to be using either traditional or improved (modern) technology. The specific activities associated with either of the technology categories adopted for this study are shown below:

Activities associated with improved technology	Activities associated with traditional technology
Rearing cross-bred or exotic cow	Rearing only Zebu cow
Artificial insemination	Open grazing with no fodder conservation
Feeding: dairy meal, maize bran, mineral salt, local salt, brewers' waste	No artificial insemination No improved housing

4.3. Results

4.3.1 Types of farmers

The distribution of farmers according to their borrowing status and liquidity constraint condition is shown in Table 4.1. Thirty eight percent of farmers in the sample were borrowers and 62% non-borrowers. A greater proportion of farmers were classified as liquidity non-constrained when the whole sample is considered. However, there were relatively more liquidity constrained farmers among borrowers and more liquidity non-constrained farmers among non-borrowers. We found a statistically significant relationship between farmers' borrowing status and liquidity constraint condition.

Table 4.1. *Distribution of sample households by borrowing and liquidity status.*

	Borrowers		Non-Borrowers		Total	
	n	%	n	%	**n**	**%**
Liquidity constrained	21	58	5	9	**26**	28
Liquidity non-constrained	15	42	53	91	**68**	**72**
Total	36	100	58	100	94	100

Chi-square between borrowing and constraint status of farmers = 27.44, significant at 5% level.

Table 4.2 shows the various sources from which farmers obtained loans. Of all the borrowers, 67% obtained loans from co-operatives, only 20% obtained loans from commercial banks while 3% obtained from relatives and friends and 11% from other sources such as non-governmental organisations (NGOs). Cash loans accounted for over 90% of the loans received.

Table 4.2. *Sources of loan by liquidity status.*

	Liquidity constrained		Liquidity non-constrained	
Source of loan	n	%	n	%
Bank	3	14	4	27
Cooperatives	14	68	10	67
Friends/relatives	1	4	–	–
Other	3	14	1	6
All sources	21	100	15	100

Forty seven percent of the borrowers from formal sources (i.e. banks and cooperatives) were classified as liquidity constrained while 39% were liquidity non-constrained. On average, liquidity non-constrained farmers reported receiving larger loans. The average size of loans for non-constrained farmers was Ksh 23,120 while that for constrained farmers was Ksh 15,085.[13] Fifty seven percent of liquidity constrained farmers reported receiving a smaller loan than they requested for while 33% of liquidity non-constrained farmers reported receiving less loan than they requested for.

13. In 1992, 1 US$ = 32.217 Ksh

Thirty eight percent of liquidity constrained borrowers and 43% of liquidity non-constrained borrowers reported purchase of cows as the major reason for obtaining loans. Relatively more borrowers, irrespective of liquidity constraint status, used their loans for purposes other than purchasing dairy cows. The duration of loans varied between 1 to 5 years. The majority of borrowers with outstanding loans reported that scheduled repayments were required. Over 85% of borrowers reported making loan payments on time while about 15% were not making them on time. The main reason farmers gave for not making timely loan repayment was that they were not making enough money to pay back the loans.

It would be ideal if loans for dairy activities were paid out of revenues from the dairy enterprise but this was not the case for some farmers. Forty three percent of liquidity constrained farmers and 60% of liquidity non-constrained farmers indicated they paid back their loans through revenues from milk sales. All the liquidity constrained farmers and 87% of liquidity non-constrained farmers made repayments through a combination of revenues from milk sales and off-farm income; while the rest paid loans from off-farm income.

4.3.2 Demographic characteristics of households

The sample comprised 94 households with an average family size of about 5 (Table 4.3). About 72% of the household heads were male while 28% were female. Among liquidity constrained non-borrowers; all the household heads were male. Only 3% of household heads were below the age of 30 years, 28% between 30 to 45 years 36% between 45 to 60 years, and 33% were over 60 years of age.

Table 4.3. *Demographic characteristics of farm households.*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Sex of household head	n	%	n	%	n	%	n	%
Male	18	86	9	60	5	100	36	68
Female	3	14	6	40	–	–	17	32
Average family size	6		4		4		4	
Any formal education								
Male	17	94	9	160	4	80	31	86
Female	1	33	6	100	–	–	12	71
Attended livestock training	12	57	5	33	2	40	12	23

Chi-square between level of education and borrowing status = 3.12; Chi - square between level of education and constraint condition = 3.14; Neither significant at the 5% level.

Education of farmers is regarded as critical in creating awareness. In general, many farmers had received some type of education. Twenty seven percent of female household heads had no formal education, 50% had primary education, 8% had secondary school education and 15% had post-secondary school education. Among male household heads, 10% had no formal education, 57% had primary education, 19% had secondary school education and 13% had post-secondary school education. Farmers' level of education was not significantly related to either their borrowing status or liquidity constraint condition but there was a strong bias towards male household heads. The proportion of female-headed households with some formal education was relatively low compared to male-headed households irrespective of farmers borrowing status or liquidity constraint condition.

Since formal education may bear no relationship with farming skills, farmers' attendance at livestock training and seminars was considered. Overall, about one-third of farmers in the survey had participated in a livestock training session or seminar (Table 4.3). Considering the type of training, 19% of female household heads and 46% of male household heads were trained in veterinary science or agriculture The highest proportion of these farmers were among those who were liquidity constrained borrowers and liquidity non-constrained non-borrowers. However, within group comparison of farmers' attendance at livestock training shows that liquidity constrained borrowers were more likely to have attended these sessions while liquidity non-constrained non-borrowers were least likely to have attended them. We found that attendance at livestock training and seminars was significantly related ($p < 0.05$) to both farmers' borrowing status and liquidity constraint condition.

4.3.4 Farm characteristics and technology use

The majority of farms were small in size. The frequency of farm below 2 acres ranged from a low of 5% among liquidity non-constrained non-borrowers to a high of 60% among liquidity constrained non-borrowers. Liquidity non-constrained borrowers reported the largest average

farm size while both liquidity constrained borrowers and non-borrowers reported fairly similar average farm sizes. In general, the size of natural pasture was smaller compared to the managed grazing area and planted pasture. The total area allocated for animal feed was, however, relatively small compared to the area under crops (Table 4.4). We did not find any significant differences ($p > 0.05$) in either total farm size, grazing area, natural and planted pasture, or crop area among liquidity constrained and non-constrained farmers irrespective of their borrowing status.

Table 4.4. *Average land usage (Acres).*

	Borrowers		Non-borrowers	
Land type	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Total farm area	2.54 (2.22)	2.97 (2.91)	2.53 (2.82)	2.64 (2.12)
Grazing area	0.24 (0.56)	0.63 (0.77)	0.28 (0.26)	0.39 (0.65)
Natural pasture	0.02 (0.08)	0.30 (0.37)	0.10 (0.14)	0.16 (0.46)
Planted pasture	0.23 (0.39)	0.35 (0.63)	0.80 (1.51)	0.34 (0.62)
Crop area	1.15 (1.45)	2.29 (2.88)	1.20 (1.34)	1.68 (1.76)
Area under homestead	0.51 (0.49)	0.54 (0.48)	0.30 (0.11)	0.44 (0.47)

Figures in parenthesis are standard deviations.

The herd size was in the range of 1–15 but about 50% of the farmers kept between 1–2 cattle. Farmers kept an average of 6– 8 cattle per farm. There were more crossbred than exotic animals and very few animals of local breeds On average liquidity non-constrained borrowers had the largest size herd while liquidity non-constrained non-borrowers had the smallest size herds. The borrowing status or liquidity constraint condition of farmers did not have any significant effect ($p > 0.05$) on average holdings of livestock per farm. Crossbred cows were dominant in the dairy herds (Table 4.5). On average, farmers kept between 2–3 crossbred dairy cows per farm. Overall, there were no significant differences ($p>0.05$) in average holdings of exotic or crossbred cows among liquidity constrained and non-constrained farmers irrespective of their borrowing status.

Table 4.5. *Average holding of ruminant animals per owning farm (TLU).*

	Borrowers		Non-borrowers	
Type of animal	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
All Cattle	5.92	7.84	6.14	5.58
Local breed	(1.91) 0.19	(5.46) 0.13	(3.67) 0.60	(3.17) 0.31
Exotic	(0.68) 5.73	(0.35) 7.71	(1.34) 5.54	(1.33) 5.27
Dairy cattle	(1.83) 2.86	(5.54) 3.53	(3.71) 2.80	(2.59) 2.70
Exotic	(0.96) 1.40	(1.85) 2.56	(1.48) 1.50	(1.20) 1.67

Cross-bred	(0.52) 2.25	(2.55) 2.55	(0.71) 2.20	(0.82) 2.02
Indigenous	(1.12) 1.00	(1.13) 1.00	(0.84) –	(1.10) 1.00
Small ruminants	0.17 (0.27)	(0.35 (0.47)	– –	1.16 (0.26)
Local	0.04 (0.12)	– –	– –	0.16 (0.26)
Exotic	0.13 (0.26)	0.35 (0.47)	– –	0.12 (0.24)

Figures in parenthesis are standard deviations.

Using the two categories of traditional and modern technologies, it was found that about 62% of farmers in the entire sample were using modern dairy technologies while 38% were still using traditional technologies. Almost all farmers kept either exotic or crossbred cows and were using concentrates and improved forages as supplementary feed. About 67% of farmers practised zero grazing. Others practised mainly open grazing while a few practised tethering (Table 4.6).

Table 4.6. *Number of farmers using improved technologies, 1992/93.*

Type of technology	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
	n	%	n	%	n	%	n	%
Cross-bred & exotic cows	21	100	14	93	5	100	53	100
Concentrate feeds	20	95	14	93	5	100	53	100
Different forages	20	95	14	93	5	100	53	100
Zero grazing	15	71	9	60	1	20	38	72

Farmers fed different type of concentrates and forages as supplementary feed. Dairy meal was the most important concentrate fed to animals. On average, liquidity non-constrained farmers fed larger amounts of concentrate per animal than liquidity constrained farmers. Among borrowers liquidity constrained farmers fed relatively more forage per animal than liquidity non-constrained farmers while among non-borrowers liquidity non-constrained farmers fed relatively more forage per animal than liquidity constrained farmers (Table 4.7). Farmers' borrowing status or liquidity constrained condition, however, did not have any significant effect ($p>0.05$) on the average quantity of either concentrate or forage fed per animal. When concentrate was disaggregated into different types, we found significant differences ($p<0.05$) among liquidity constrained and non-constrained farmers in average quantities of feeds fed per animal.

Table 4.7. *Average quantities of supplementary feeds consumed (kg/animal), 1992/93.*

Type of feed	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Concentrate	0.98 (0.52)	1.30 (1.13)	0.41 (0.36)	1.20 (1.39)
Forages	17.32 (8.18)	16.95 (9.15)	12.45 (3.64)	15.85 (6.78)

Figures in parenthesis are standard deviations.

The use of family labour was dominant in all activities providing about 82% of total labour input while hired labour provided 18%. The activities for which hired labour was engaged were similar to those performed by family labour. Feeding cows accounted for the highest proportion of total labour time for all farmer categories (Table 4.8). On the other hand, activities such as artificial insemination and animal disease control took up negligible amounts of time. This was because these activities were not undertaken every day. When they were undertaken, farmers spent an average of about 2 hours on artificial insemination and animal disease control.

Table 4.8. *Proportion of total labour hours spent in various livestock activities.*

	Borrowers		Non-borrowers		All farmers
Activity	Liquidity Constrained %	Liquidity non-constrained %	Liquidity constrained %	Liquidity non-constrained %	%
Herding	1	10	1	3	3
Feeding cows	58	64	60	62	60
Disease control	n	n	n	n	n
Milking cows	13	4	16	11	12
Milk delivery	15	6	6	14	14
Cleaning	4	1	3	3	3
Herding	1	10	1	3	3
Fetching water	5	6	6	4	5
Others	4	8	7	2	3
All activities	100	100	100	100	100

n = negligible, i.e. less than 0.5%.

4.3.4 Milk production and disposal

Milk output per farm depends, in part, on the number of milking cows on the farm, levels of input use and farmers' herd management practices. Eighty percent of the farmers in the entire sample had no more than 2 lactating cows. Milk yield per cow ranged between 1544 kg per year for farms with larger herds to 4500 kg per year for farmers owning one lactating cow. These yields were relatively low compared to those reported for well-managed farms in research stations (over 7000 kg per year). The liquidity constrained farmers obtained yields ranging from 210 kg per year for one farm[14] with 4 animals in milk to 4155 kg per year for those with one dairy animal. The liquidity non-constrained farmers recorded an average annual milk yield per animal of 2210 kg for those with larger herds to 5039 kg for those with one dairy cow. It appears that having fewer dairy cows was associated with higher milk yield. This might be attributed to the adequate care and attention accorded to fewer animals by the owners compared to those with larger herds. Average daily milk yield per farm ranged from 4.9 litres to 7.0 litres (Table 4.9). Among borrowers, liquidity-constrained farmers had slightly higher average daily milk yield per farm than liquidity non-constrained farmers. On the other hand, liquidity non-constrained farmers recorded higher average daily milk yield per farm than constrained farmers among non-borrowers did. These differences were, however, not statistically significant. ($p>0.05$)

14. Those cows of this farm unexpectedly stopped giving milk within the survey year, hence the poor yield.

Table 4. 9. *Average daily milk yield per cow (litres).*

Breed of cow	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Exotic	8.54 (2.38)	6.36 (1.51)	9.44 (–)	9.02 (4.32)
Cross-bred	5.97 (2.44)	6.73 (2.19)	6.05 (–)	6.45 (1.90)
Indigenous	9.27 (3.86)	5.96 (2.20)	– –	5.21 (1.97)
All	6.98 (1.95)	6.33 (1.37)	4.92 (2.58)	6.72 (3.00)

Figures in the parentheses are standard deviations.

Table 4.10 shows the various outlets farmers used to dispose of milk and the total quantities of milk disposed of daily through each outlet. Selling liquid milk was clearly the most important form of disposal. All categories of farmers reported consuming at least about 20% of total milk produced on farm and sold over 60% of output. On average, farmers sold between 5 and 7 litres of liquid per day. Liquidity non-constrained farmers reported selling larger quantities of milk per day compared to liquidity constrained farmers although these differences were not statistically significant ($p>0.05$).

Table 4.10. *Average daily milk disposal per farm by type of disposal (litres).*

Type of disposal	Borrowers		Non-borrowers	
	Liquidity Constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Fed to calves	0.65 (7)	1.77 (12)	0.66 (9)	0.56 (6)
Consumed fresh	2.49 (21)	2.89 (22)	1.98 (26)	2.16 (27)
Other uses	0.11 (1)	0.08 (–)	0.15 (2)	0.21 (2)
Wasted	0.08 (–)	0.14 (1)	0.05 (1)	0.06 (1)
Sold	6.51 (71)	7.17 (66)	4.97 (62)	5.25 (64)
Total	9.52 (100)	11.23 (100)	7.58 (100)	7.89 (100)

Figures in parenthesis are percentages.

4.3.5 Income and expenditure

Income from the sale of dairy products provided between 47 and 61% of total household cash income. Among borrowers, liquidity constrained farmers realised a higher proportion of cash income from dairy sources while, among non-borrowers liquidity constrained and non-constrained farmers realised about similar proportion of cash income from dairy sources. Sale of livestock and livestock products was the second most important source of cash income among all categories of farmers. When income from the sale of dairy products was combined with income from sale of livestock and livestock products, we found that income from livestock sources provided 71 to 94% of household cash income in the entire sample. Income from crop

sales and off-farm income were relatively unimportant sources of cash income for all farmer categories except among liquidity non-constrained borrowers where income from crop sales provided slightly over 20% of cash income (Table 4.11).

Table 4.11. *Sources of household cash income per farm (Ksh).*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Income source	Ksh	%	Ksh	%	Ksh	%	Ksh	%
Milk sales	71903	61	10432	47	4692	57	82	55
Sale of livestock and livestock products	28137	24	5410	24	3103	37	5279	35
Crop sales	8634	7	4762	22	429	5	827	6
Feed sales	178	-	-	-	-	-	66	neg.
Other income	8836	8	1500	7	48	1	570	4
Total	117688	100	22104	100	8272	100	14960	100

Average input cost per TLU and its distribution per farm shows that the largest proportion of input cost was allocated to buying concentrates (Table 4.12). When the cost of concentrates was added to the cost of forages, we found those feed costs that was the most important component of input cost. There was no significant difference in average input cost per TLU when borrowers and non-borrowers were compared. Liquidity constrained borrowers reported higher average expenditure on concentrates and forages than those reported by liquidity non-constrained borrowers. Among the non-borrowers, liquidity non-constrained farmers had higher average expenditures on concentrates and forages compared to liquidity constrained farmers. Expenditure on veterinary services was in the range of 1–13% of input cost with liquidity non-constrained farmers having the least expenditure and liquidity constrained non-borrowers the highest. Gross margin per TLU was the highest for non-borrower liquidity non-constrained farmers and lowest for liquidity constrained borrower (Table 4.13).

Table 4.12. *Average input cost over the survey period (Ksh/TLU).*

	Borrowers				Non-borrowers			
Input	Liquidity constrained	%	Liquidity non-constrained	%	Liquidity constrained	%	Liquidity non-constrained	%
Concentrates	11198 (22834)	48	7957 (12419)	86	1121 (710)	40	2439 (6031)	53
Forages	2535 (4021)	11	165 (184)	2	701 (748)	25	800 (1427)	18
Veterinary services	1705 (3507)	7	128 (119)	1	341 (407)	13	294 (367)	6
Other inputs	7911 (16834)	34	1016 (1141)	11	613 (928)	22	1049 (2062)	23
Total	**23350**		**9266**		**2776**		**4582**	

Figures in parenthesis are standard deviations.

Table 4.13. *Gross margin per TLU (Ksh).*

	Borrowers		Non-borrowers	
	Liquidity	Liquidity non-	Liquidity	Liquidity non-

	constrained	constrained	constrained	constrained
Revenue from milk sales	8774	760	846	1085
Revenue from other sources	14039	13446	5238	14155
Total revenue per TLU	22813	14206	6084	15240
Total input cost per TLU	22643	8653	2361	4152
Gross margin per TLU	170	5553	2723	11088

4.4 Conclusion and policy implications

This study sought to understand the role of credit and liquidity in the uptake and continued use of dairy technology to improve milk production in Kenya. The government aims at maintaining self-sufficiency in milk and milk products and achieving surplus for export if possible. Productivity increases ought to come from application of appropriate technologies and inputs and provision of an enabling environment to facilitate efficient milk marketing. Adoption of available technology requires additional funds, which can be obtained from savings or loans. Using a sample of smallholder farmers from Kiambu district in Kenya, the study identified borrowers and non-borrowers, and liquidity constrained and non-constrained farmers, and then determined the extent to which each group was using available technologies and the output levels achieved.

Farmers in the study area were generally aware of the dairy technologies considered but adoption was constrained by liquidity as well as other socioeconomic factors. About 98 percent of the farmers kept exotic or crossbred dairy cattle. However, concentrates, which constitute a major input for increased milk yield, were not being offered adequately to the dairy animals since only between 0.5 and 1.0 Kg was offered per animal while research stations report offering about 2.0 Kg for their lactating animals. The liquidity constrained farmers used less of these inputs with the result that milk yield was significantly lower than those obtained by liquidity non-constrained farmers. Both groups of farmers adopted the use of Napier grass, which was recommended as a good forage by the extension service. The fact that farmers were aware of the technologies but liquidity constrained farmers were offering relatively less amounts of purchased inputs implied that these farmers lacked the necessary dairy working capital. Since 45% of liquidity constrained farmers gave the reason for not borrowing as being the fear for credit, there was a need for them to be assured of obtaining sufficient returns on invested credit funds to enable them to pay back the loans. An education campaign to make farmers know that enterpreneurship involves risk-taking should be mounted, otherwise the risk aversion will persist with consequent low investment in improved technologies.

The cooperatives appeared to be the principal source of credit funds. The Agricultural Finance Corporation, the parastatal associated with agricultural lending activities, played no role in giving credit to the smallholder dairy producers in the study area. There is therefore a need to promote more cooperative activities to enable farmers to get access to the credit for their needs. Since interest rates charged by informal sources were prohibitive (over 250 % per annum), this source cannot play a major role in availing credit for farmer investment. Commercial banks also did not feature in the study area as a source of credit. Borrowing from commercial banks continues to be the bane of the agricultural sector countrywide.

Over half of those who borrowed were still facing liquidity constraints. This implies that the amounts approved by the credit sources appeared low compared to farmers' requirement. There is therefore a need to lend to farmers adequate funds to meet their investment needs. Inadequate lending is likely to lead to under-investment or diversion of the funds for immediate consumption rather than long term investment.

The study showed that with respect to milk production per animal, liquidity constrained farmers

produced significantly less than liquidity non-constrained farmers. There were strong indications that credit had an important role to play in overcoming liquidity constraint and in the use of improved technology and subsequently increased yield. Similar results were found for the profitability difference between the groups of farmers. Liquidity non-constrained farmers on average achieved almost ten times the level of dairy gross margins obtained by the liquidity constrained farmers. This implies that improving access to credit will lead to greater incentives to adopt improved dairy technologies and hence achievement of higher output and net returns.

The yields attained by the farmers appeared generally low (2000 – 5000 kg of milk per lactating cow) compared to those achievable in well managed farms (about 7000 kg). This may imply that farmers were not providing efficient management to the dairy animals to enable the achievement of higher yields. In particular, concentrate levels offered to the animals were very low (0.5 –1.0 kg per animal per day). The results also indicated that farm size *per se* did not have a significant influence on yields. This is an important finding in view of the intense pressure on high potential lands in the country, particularly in peri-urban locations such as Kiambu district where the survey was conducted. It is recommended that close liaison between dairy researchers, extension workers and farmers be fostered with a view to intensifying technology use in the emerging small land parcels. The complementary role that credit can play in this regard has been amply demonstrated in this study. There is thus a need for exploring policies, which are likely to enhance farmers access to and efficient use of credit.

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Chapter 5 Role of credit in the uptake and productivity of improved dairy technologies in Uganda

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5.1 Background and objectives

Uganda with a population of over 16.8 million (1991 census) has a land mass of 24.1 million ha, of which 5 million ha (20.75%) is arable land, 7.21 million ha (29.9%) is under open water and swamps, 1.63 million ha (6.73%) is under forests and game reserves and just 5.543 million ha (23%) is available for grazing, remaining 4.72 million ha (19.6%) has degenerated into unproductive semi-dry grasslands. According to the 1991 National census of agriculture, there are about 4.6 million cattle, 3.8 million goats, 0.7 million sheep, 0.47 million pigs and 10.0 million poultry birds in the country. Uganda produces approximately 300 million litres of milk per year of which about 75% comes from local cows that produce 1.5 to 3.0 litres per cow per day. Uganda's milk production meets only 65% of the national requirements.

During the last five years, attempts have been made to encourage dissemination of improved livestock production technologies such as introduction of dairy cattle, artificial insemination and exotic bulls to service local cows, and zero grazing systems for dairy cattle. Provision of credit to encourage adoption of these technologies has been promoted through development projects such as the one run by Heifer Project International.

In Uganda, loans for livestock farmers come primarily from the government owned Uganda Commercial Bank (UCB) and the Uganda Cooperative Bank. In recent years, UCB has been making loanable funds available to farmers through the Rural Farmers Credit and Development Finance Scheme. Currently the lending interest rates have been reasonably reduced from 37% to about 20–25%. However, for livestock loans, UCB requires evidence of some infrastructure like fenced pasture for keeping livestock and proven experience of livestock husbandry. Although UCB has tried to minimise lenders transaction costs, there are delays between the application and disbursement of the loans thus reducing the effectiveness of the loan funds. On the other hand, the Uganda Cooperative Bank has had several credit schemes such as crop finance targeted at farmers' cooperative societies, credit for crop production and construction of store, both financed by the Swedish Cooperative Centre in collaboration with Uganda Cooperative Alliance.

Unfortunately, the impact of credit on livestock operations has not been studied with the same intensity as its impact on crop based farming operations. Considering the importance of livestock in Sub-Saharan Africa as sources of meat, milk, traction, manure, transport, cash income and employment for the inhabitants of the sub-region, there is a need to determine the extent to which liquidity limits livestock productivity and technology uptake and how far credit can overcome those constraints.

For this reason, it was hypothesised that the small scale dairy farmers in the peri-urban areas

such as around Kampala, due to their proximity to large milk market, would be encouraged to invest more funds and to have higher levels of adoption of dairy production technologies in order to increase their milk sales. Since the adoption of improved livestock technologies necessitates the purchase of the associated inputs and services, it is further hypothesised that once the small livestock farmer is certain of the market for his/her dairy products, he/she will seek additional funds through formal or informal credit to boost his/her own small savings to enable him/her adopt new technologies which will raise livestock productivity and generate higher net returns. This will increase the capacity for servicing the loan and for future re-investments. In other words, a small livestock farmer who has limited liquidity and limited access to credit in order to generate investible funds, may not be able to adopt new technologies since he has limited capacity to purchase the associated inputs and services.

This study was conducted in Uganda during the period January – December, 1993 with the following objectives: (a) assess the extent to which smallholder dairy farmers are using improved dairy technologies, (b) determine if credit and liquidity influence the uptake of improved technologies, © determine the relative milk productivity of liquidity constrained versus non-constrained farmers given their resource and marketing conditions.

Sample selection and data collection methods are described in section 5.2, results are discussed in section 5.3 and policy conclusions are drawn in section 5.4.

5.2 Materials and methods

5.2.1 Selection of area and sample

The study was carried out in the districts of Mukono and Mpigi in the central region of Uganda surrounding the capital city of Kampala and they lie in the fertile crescent just north of Lake Victoria, an area with a very high agricultural potential. This area has the highest concentration of smallholder dairy farms of all the 39 districts of Uganda. Because of financial and other logistical constraints, only farms within a radius of 32 km from the city centre along the arterial highways were selected. Hence the study involved basically peri-urban smallholder dairy farms. Farms in these districts are known to be more commercial oriented than in other areas because of their proximity to Kampala city.

A three stage sampling procedure was adopted. A rapid baseline survey was carried out in 8 sub-countries within a radius of 32 km from the centre of Kampala city. Since most interventions (feed, genetic and health) have taken place more in dairy production than in other forms of livestock production, and given that milk is a readily measured output, the study involved those farmers whose predominant occupation was milk production. Two sets of farmers were used: those who borrowed, and those who did not borrow to use certain livestock technologies. Only smallholder dairy farms were considered. These included farms having not more than 10 head of exotic and/or crossbred cattle and with milk as the predominant output. To be able to capture some farms that had benefited from bank loans, some farms outside the brackets of the above criteria were also considered.

This initial baseline survey generated basic data and characteristics of a total of 500 farms. From this initial sample, a sample of 200 farms was drawn purposely depending on the following characteristics: (a) accessibility of the farm, (b) herd size of less than 10 heads of cross-bred and/or exotic cows, (c) possession of cattle at early lactation or late pregnancy, (d) whether benefited from any formal credit scheme, and (e) willingness to co-operate in the research project. Out of the purposively selected 200 farms, a final sample of 99 farms was drawn randomly. Of these, 46 had benefited from some kind of credit facilities. Eventually some farmers dropped out for various reasons leaving a total of 73 farmers who provided most of the information required for analysis.

5.2.2 Collection of data

Collection of data was accomplished in 2 stages. Stage I involved training of enumerators. These in turn sensitised farmers in their respective areas about the type of data required, how to record the required information and the importance of making accurate records. During this phase, questionnaires were pretested and redesigned. Stage II involved actual field data collection over a period of 52 weeks starting from January 1993. Recording of information was done by personnel fully resident on the farm, and by monitoring all livestock related activities on a daily basis. Equipment were provided to facilitate accurate recording of data. For example, wristwatches were provided for recording time; weighing scales for measuring quantities of feed; and calibrated jugs for measuring quantities of milk. The enumerators were provided with bicycles to facilitate transport. Those who had motorbikes were provided with fuel allowances. Feed troughs (wooden) were provided to farms where they were lacking.

All required information was first recorded in well organised notebooks on a daily basis, then it was entered into questionnaires by the enumerators on a weekly basis. Questionnaires for land and herd inventories were provided at the beginning of every month. All properly filled questionnaires were returned to the project office by the enumerators at intervals of four weeks. At this time a meeting of the enumerators, collaborators and facilitators was organised to review the progress of data collection, identify constraints and find solutions.

General information about the farming household was obtained once, during the baseline survey. This included such information as geographical location of the farm; and household composition, levels of education, whether the farmer obtained a loan, the source and for what purpose; and terms of lending. Daily records included feed usage, milk output, milk disposed, labour use, all inputs purchased, revenues, action and events.

The feed intake for all cattle on the farm was recorded individually. The name or number of the cattle, the type of feed and amount in kg actually consumed by the animal were recorded. his was obtained by weighing the total feed offered in the course of a day less remains and wasted feed.

Individual cow milk yield at each milking and the day's total yield in litres were recorded. Yields of individual cows were added to obtain daily total milk yield of the farm. The total milk produced on the farm, the amount fed to calves, consumed fresh, converted to butter, wasted and that sold was recorded each day. The price per litre and the total value of the sales were also recorded.

The time taken by any member of the family to accomplish any livestock related activity was recorded in minutes and later converted into hours by the enumerator. The name of the member, sex, ages and type of work done were also recorded. For any person hired to do any livestock related activity, the type of work done, the time taken to accomplish it and the amount of money paid were recorded. The name, age and sex of the worker; and whether he/she was a casual or contract worker or a monthly wage earner were also indicated.

A record of all livestock related expenditure including labour was kept. For each item purchased, the amount purchased, the price per unit and the total cost were recorded. All forms of revenue accruing to the farm including that from milk were recorded. For example revenue from sale of livestock products, sale of crops, animal feeds, beverages, off-farm employment, rent of house, retirement benefits, etc. were recorded.

Health and non-health related actions and events associated with the cattle were recorded. For example, any symptoms of disease, any remedy given, weaning of calf, drying-off of cow, cow served, animal died, sold, culled, stolen or had an accident were all recorded on a daily basis.

Weekly records included all formal and informal credit facilities received by the farm. The amount, source and form of credit and its purpose were also recorded. Monthly records included land inventory and herd inventory. The total farm size, the size of the grazing area, planted and natural pastures were recorded at the beginning of each month. Also recorded were the crops grown, size of land fenced, types and changes in ownership of the land, and the sources of water used on the farm. Types of animals in respect of age, breed, sex were recorded and converted into Tropical Livestock Units (TLU) at the beginning of each month using the following conversion factors : mature females = 1 TLU, mature bulls and oxen =1 TLU, heifers 1–2 years = 0.75 TLU, bulls 1-2 years = 0.80 TLU, calves 6-12 months = 0.40 TLU, calves under 6 months = 0.20 TLU, sheep and goats = 0.10 TLU.

5.3 Results

5.3.1 Characteristics of farmers and households

The distribution of farmers according to whether they were borrowers or non-borrowers and their liquidity constraint condition is shown in Table 5.1. About 45% of households were borrowers. Fifty three percent of the farmers were characterised as liquidity non-constrained and 47% liquidity constrained. Sixty percent of liquidity constrained farmers were among farmers who borrowed. There was a significant relationship ($p < 0.05$) between the borrowing status of farmers and their liquidity constraint conditions.

Table 5.1. *Distribution of sample farmers according to borrowing and liquidity constraint status.*

	Borrowers		Non-borrowers		Total	
	n	%	n	%	n	%
Liquidity constrained	20	61	14	35	34	47
Liquidity non-constrained	13	39	26	65	39	53
Total	33	100	40	100	73	100

Chi square between borrowing and constraint status of farmers = 4.765, significant at 5% level.

Thirty three out of 73 household heads, representing 45% of the sample, received loans from formal and/or informal sources. Six farmers borrowed from the bank, 23 farmers from other sources such as non-governmental organisations (NGO's) or informal sources such as relatives and friends. Only 2 farmers reported receiving cash loans. The rest were given in kind (cows, water pipes, drugs) or in combinations of cash and kind. About one third of the borrowers were recommended by a development agency and 42% by other unspecified agencies. Amount of cash loans varied from Ush 334,500 to 1,561,000.[15]

15. At the time of the survey, 1 US$ = 1134 Ush.

Sixty four percent of borrowers reported making scheduled loan repayments while 3% did not make loan repayments because of insufficient income. When loan repayment was disaggregated by constraint conditions, 11% of liquidity constrained and 90% of liquidity non-constrained farmers reported making scheduled repayments. The most common reason farmers gave for not making scheduled repayment was the perception that the loan was a free government service. Only 15% of liquidity constrained and 10% of liquidity non-constrained farmers used revenue from milk sales as the sole source for repaying loans. Sixty seven percent of these borrowers used the loans to purchase dairy cows: of these, 41% were liquidity constrained and 27% liquidity non-constrained farmers. Informal credit obtained in small amounts (usually less than $50.00) on daily or weekly basis were used mainly to

purchase feed, health inputs, and hire labour.

Forty eight (66%) out of 73 household heads were males and 25 (34%) were females. Of the 33 farmers who borrowed, 14 (42%) were females and 19 (58%) males. Slightly more than one quarter of the heads of households had attained at least primary education. In general, male household heads attained higher levels of education compared to female household heads. Thirty one percent of male household heads had some post-O'level education (post high school) compared to 8% for female household heads.

5.3.2 Livestock holdings and technology use

Cattle constituted the largest proportion of TLUs held by the farmers. Three hundred and fifty cattle were involved in the study of which only 3% were local breeds, the rest being exotic or cross-bred cattle. Farmers who did not borrow kept an average of 5 exotic cattle per farm while farmers who borrowed kept an average of 4 exotic cattle per farm (Table 5.2). On average, liquidity constrained farmers kept more cattle per farm than liquidity non-constrained farmers among both borrowers and non-borrowers but these differences were not statistically significant ($p>0.05$). The number of cattle held was, however, found to be significantly correlated ($p<0.5$) with farm size and grazing area. Liquidity constrained farmers had significantly larger ($p<0.05$) grazing areas averaging 5.3 acres compared to an average of 3 acres for liquidity non-constrained farmers (Table 5.3).

Table 5.2. *Average livestock holding per farm (TLU).*

	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Cattle	4.08 (3.87)	2.22 (2.16)	4.43 (2.38)	3.57 (2.53)
Small ruminants	0.11 (0.22)	0.08 (0.13)	0.06 (0.09)	0.11 (0.23)
Total	**4.19 (3.96)**	**2.30 (2.20)**	**4.49 (2.35)**	**3.68 (2.53)**

Figures in parentheses are standard deviations.

Table 5.3. *Average farm size (acres) by borrowing and liquidity status.*

	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Total farm size	9.51 (8.86)	6.08 (7.51)	8.93 (8.75)	7.04 (7.87)
Grazing area	5.85 (5.97)	1.77 (3.39)	4.96 (5.51)	3.57 (5.09)
Cultivated area	3.66 (3.29)	4.31 (4.57)	3.97 (5.10)	3.47 (4.74)

Figures in parenthesis are standard deviations.

Table 5.4 shows the number of farmers who were using components of improved dairy technologies. All farmers reported keeping at least one exotic or crossbred animal. Overall, the intensity of use of crossbred cow was relatively high in this sample considering the fact that they accounted for over 90% of the dairy herd. The number of farmers who reported using

forages was very high: 89% for Npier, 84% banana peeling and 77% potato vines. Among those who used various concentrates, 82% used dairy meal, 60% used maize bran, 51% used salt, 40% used sunflower cake and 27% used mineral salt. The pattern did not differ by borrowing or liquidity constraint status.

Table 5.4. *Number of farmers using different concentrates and forages.*

	Borrowers				Non-borrowers			
	LC		LNC		LC		LNC	
Type of feed	n	%	n	%	n	%	n	%
Concentrate								
Dairy meal	16	80	13	100	8	57	23	88
Cotton seed cake	1	5	0	–	0	–	1	4
Sunflower cake	0	–	0	–	0	–	4	15
Maize bran	6	30	4	31	7	50	12	46
Mineral salt	11	55	8	62	7	50	18	69
Local salt	3	15	3	23	6	43	8	31
Forage								
Napier grass	17	85	13	100	11	79	24	92
Banana peeling	18	90	11	85	9	64	24	92
Potato vines	16	80	12	92	9	64	19	73
Others	16	80	13	100	9	64	23	88

LC = Liquidity constrained LNC = Liquidity non-constrained.

During the survey period, forages accounted for slightly over 80% of the total feed dry matter (Table 5.5). The most important forage was Napier (elephant grass), followed by potato vines and banana peelings. Napier also accounted for over 65% of total forages consumed among all farmer categories. On average, liquidity non-constrained farmers fed cows the largest quantity of forage per farm on a daily basis among both borrowers and non-borrowers (Table 5.6). Farmer's borrowing status or liquidity constraint condition, however, was not significantly related ($P > 0.05$) to the differences in average daily quantities of forages consumed per cow.

Table 5.5. *Share of different forages and concentrates consumed during survey period (% of DM kg).*

	Borrowers		Non-borrowers	
Feed type	Liquidity constrained %	Liquidity non-constrained %	Liquidity constrained %	Liquidity non-constrained %
Forage				
Napier grass	78	75	77	64
Banana peeling	4	8	6	9
Potato vines	10	12	8	16
Other forages	8	5	9	10
Total	100	100	100	100
Concentrate				
Dairy Meal	97	88	72	90
Other concentrates	3	12	28	10
Total	100	100	100	100

Table 5.6. *Average quantities of supplementary feeds consumed during survey period (kg/animal).*

Feed type	Borrowers		Non-borrowers	
	Liquidity constrained	Liquidity non-constrained	Liquidity constrained	Liquidity non-constrained
Concentrate	2.69 (1.46)	2.95 (2.57)	2.06 (1.25)	2.87 (1.63)
Forage	6.23 (2.77)	7.27 (2.19)	5.94 (2.16)	7.14 (3.11)

Figures in parenthesis are standard deviations.

Forages were usually supplemented with concentrates. The proportion of farmers using dairy meal ranged from 57% among liquidity constrained non-borrowers to 100% for liquidity non-constrained borrowers. Dairy meal was also used most frequently by all farmers accounting for over 70% of total concentrate consumed in terms of dry matter. The second most important concentrate was maize bran. Liquidity non-constrained farmers on average fed relatively more concentrates per cow on a daily basis than liquidity constrained farmers among both borrowers and non-borrowers. These differences were not significantly related ($p>0.05$) to farmer's borrowing status or liquidity constrained condition.

For the purposes of this study, investment in dairy related infrastructure were regarded as investment in improved management practices. Fifty one percent of farmers fenced and relatively more non-borrowers than borrowers reported fencing their farms. Unexpectedly more liquidity-constrained farmers fenced their farms than liquidity non-constrained farmers did. Farmers invested in improved water sources such as ponds (49%), piped water (15%); rivers (12%) bore holes (10%) and harnessing of rainwater (11%). Of all these water sources, ponds were the most common source of water supply irrespective of farmers' borrowing or liquidity constraint status. More liquidity non-constrained than constrained farmers invested in piped water bore holes, and harvesting rainwater in overhead and underground storage tanks. Farmers' borrowing status or liquidity constraint condition were not significantly related ($p > 0.05$) to fencing or the source of water.

The distribution of family and hired labour hours shows that feeding cows was the most intensive activity followed by milking cows. Herding accounted for relatively small amount of total labour time. There was also a clear gender division of labour. Male labour was dominant in feeding and milking cows while female labour was dominant in cleaning and fetching water. Both sexes provided about equal proportion of total labour time in distributing milk.

5.3.8 Milk production and disposal

Of the completed lactations recorded during the survey period, 79% of all milking cows produced less than 12 litres of milk per day. There were however wide variations in daily milk yield over the year with the lowest quantities recorded during July - September. There were no consistent differences in milk yield when liquidity constrained and non-constrained farmers were compared by borrowing status. Non-borrowers generally had lower milk yields than borrowers but the differences were not statistically significant ($p>0.05$). Among borrowers, liquidity constrained farmers recorded milk yield of 11.7 litres per cow per day compared to 10.7 litres for liquidity non-constrained borrowers. On the other hand among non-borrowers, liquidity non-constrained farmers recorded 8.6 litres per cow per day compared to 9.7 litres for liquidity constrained farmers. However, farmers' borrowing status or constraint condition did not have any significant effect ($p>0.05$) on average daily milk yield per cow.

Table 5.7 shows the different outlets farmers used to dispose of milk during the survey period. Selling fresh milk was the most important form of disposal for all farmers accounting for over 80% of milk disposal. Relatively small quantities were fed to calves, consumed fresh, or converted to butter. On average, liquidity constrained farmers sold larger quantities of milk per day among both borrowers and non-borrowers. These differences were, however, not statistically significant (p>0.05).

Table 5.7. *Average daily quantity of milk disposed per farm by borrowing liquidity status.*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Milk disposal	Lit/day	%	Lit/day	%	Lit/day	%	Lit/day	%
Fed to calves	1.68 (1.01)	10	1.17 (1.05)	9	1.85 (1.57)	13	1.41 (1.25)	10
Consumed fresh	0.85 (0.41)	5	0.82 (0.47)	7	1.48 (2.34)	10	0.84 (0.46)	6
Converted to butter	0.02 (0.01)	n	0.02 (0.02)	n	0.01 (0.00)	n	0.03 (0.04)	n
Wasted	0.36 (0.84)	2	0.11 (0.14)	1	0.05 (0.04)	n	0.14 (0.17)	1
Sold	14.54 (11.88)	83	10.49 (6.86)	83	10.85 (15.65)	76	11.48 (7.58)	83
Total	17.45	100	12.61	100	14.24	100	13.90	100

Figures in parenthesis are standard deviations. n = negligible, i.e. less than 5%.

5.3.4 Income and expenditure

Revenue from the sale of fresh milk provided the most important source of household cash income (Table 5.8). It contributed between 52 and 74% of cash income with the corresponding proportion lowest among liquidity constrained borrowers and highest among liquidity non-constrained borrowers. When income from the sale of dairy products was added to that from the sale of livestock and other livestock products, income from livestock sources contributed between 67 and 95% of household cash income. Crop sales and income from off-farm activities contributed 5% or less cash income in all farmer categories except for liquidity constrained non-borrowers for whom the share was slightly more than 30%. Income from non-dairy sources was the second most important source of cash income for this category of farmers. On average the farmers' incomes from the different sources were not significantly related (p>0.50) to their borrowing status or liquidity constraint condition.

Table 5.8. *Sources of household cash income ('000 Ush/farm).*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Income source	Ush	%	Ush	%	Ush	%	Ush	%
Dairy products	1397	62	1050	74	1140	52	1270	55
Sale of milk	2	n	–	–	–	–	–	–
Sale of cheese/butter	1399	62	1050	74	1140	52	1270	55
Sub-total	729	33	207	15	324	15	795	34
Sale of livestock & other	35	2	120	9	27	1	119	5

livestock products								
Crop sales								
Feed sales	19	1	5	n	21	1	22	1
Other income	55	2	33	2	681	31	113	5
Total	2237	100	1415	100	2193	100	2319	100

n= negligible, i.e. less than 0.5%.

Table 5.9 shows that the cost of concentrates accounted for the largest component of variable input cost per TLU for all farmers during the survey period. In general, cost of concentrates represented over 60% of the total input cost for all farmer categories except in the case of liquidity constrained non-borrowers for whom it represented slightly less than 40% of total input cost. Among all farmer categories, liquidity constrained non-borrowers allocated the highest proportion of total input cost to forage. Expenditure on veterinary services represented the second most important component of total input cost for all farmer categories except liquidity constrained non-borrowers for whom forages accounted for a higher proportion of total inputs cost than the cost of veterinary services. Overall, there was a significant difference ($p < 0.05$) in total variable input cost per TLU among borrowers and non-borrowers, but there was no such difference among liquidity constrained and non-constrained farmers. When total variable input cost is disaggregated into its components we found significant differences ($p < 0.05$) in average cost of concentrates per TLU among borrowers and non-borrowers but not among liquidity constrained and non-constrained farmers. Farmers' borrowing status or liquidity constraint condition were not significant ($p > 0.05$) in explaining the differences in average expenditure on forages and veterinary drugs and services.

Table 5.9. *Average input cost per TLU (Ush).*

	Borrowers				Non-borrowers			
	Liquidity constrained		Liquidity non-constrained		Liquidity constrained		Liquidity non-constrained	
Input category	Ush	%	Ush	%	Ush	%	Ush	%
Concentrate	130426 (92194)	64	92191 (94406)	63	45664 (69873)	39	62467 (54790)	61
Forages	28628 (70532)	14	10743 (15255)	7	26536 (32339)	23	9544 (7413)	9
Vet drugs & services	20969 (13850)	10	21632 (22213)	15	8942 (4632)	8	19538 (24086)	19
Other inputs	22391 (23457)	12	21803 (29644)	15	34625 (69444)	30	10743 (13590)	11
Total	202414	100	146369	100	115767	100	102292	100

Figures in parenthesis are standard deviations.

Gross margin analysis of dairy activities shown in Table 5.10 indicated that they were generally profitable activities. Among both borrowers and non-borrowers liquidity non-constrained farmers recorded the highest gross margin per TLU. This was because these farmers earned higher dairy incomes while, at the same time, maintaining relatively low total operating expenses (Table 5.9).

Table 5.10. *Gross margin per farm per TLU ('000 Ush).*

	Borrowers		Non-borrowers	
	Liquidity	Liquidity non-	Liquidity	Liquidity non-

	constrained	constrained	constrained	constrained
Dairy revenue per TLU	385	546	293	411
Input cost per TLU	202	147	117	103
Gross margin per TLU	183	399	176	308

5.3.4. Discussion and conclusion

The results showed a high proportion of liquidity constrained farmers among borrowers suggesting that many farmers received inadequate credit. A large number of farmers who received credit expressed a desire to receive more loans to finance their dairy operations. For example 61% of farmers who borrowed reported that the amount of the loan they received was not adequate for financing their dairy activities. A significant finding is that there were relatively more borrowers among females than among males. This is a consequence of substantial donor involvement in the study area, which, for the most part, targeted female farmers.

Formal credit was important for making investments such as purchasing improved breeds of dairy cows or building infrastructure. Informal credit provided important sources of funds to finance the purchase of complementary inputs. The survey results showed that exotic and crossbred cows dominated the cattle herd. Liquidity constrained farmers who received loans in the form of improved breeds of dairy cows from heifer donating projects held the largest cattle herd even though they perceived the credit they received as inadequate. The differences in average cattle holding was not significantly influenced by farmers' borrowing status or liquidity constraint condition. However, the positive correlation between herd size and grazing area suggested that a limiting constraint on increasing herd size was feed availability. The relatively large numbers of exotic and cross-bred cows held compared to local cows, and the extent of use of improved supplementary feed among all farmer categories support the hypothesis that farmers were indeed aware of the potential benefits to be derived from adopting improved dairy technologies. The high level of use of improved dairy technologies was also due, in part, to direct project interventions under which farmers were supplied with improved breeds of cows and some input. However, it is apparent that adoption of improved dairy technologies among non-borrowers was strongly driven by the perceived profitability of the improved technologies. Most liquidity-constrained farmers relied on seasonal sources of water supply such as ponds. On the other hand, liquidity non-constrained farmers were most likely to invest in boreholes or facilities for harvesting rainwater which provided year-round water supply. This finding suggested that constraints on investment capital limited the ability of liquidity-constrained farmers to invest in fixed farm assets such as barns, fences and water supply systems.

The high labour requirements for feeding and milking cows reflect the nature of the zero-grazing technology which many farmers were practising. The use of hired labour was very important to meet labour demands in this intensive production system. This finding highlights the potential employment generation effects as smallholders shift from extensive to intensive production systems.

Forages were fed more frequently to animals than concentrates irrespective of farmers' borrowing status or liquidity constraint condition. However, on average, liquidity non-constrained farmers fed larger quantities of forages and concentrates per cow although these differences were not statistically significant.

There were no significant differences in milk yield when farmers were compared by borrowing status or liquidity constraint condition. The result suggests that factors other than farmers' liquidity position were more important in explaining differences in milk yield per farm.

The high level of milk sales among all farmer categories highlighted the strong urban demand for milk in these areas. This was partly explained by the close proximity of the study area to Kampala which is a major urban centre. While, on average, liquidity constrained farmers sold more milk than liquidity non-constrained farmers, these differences were not statistically significant. Income from dairy sources was very important for all categories of farmers in this area. The higher share of supplementary feed costs and cost of veterinary services in total variable cost could be attributed to the relatively high feed and health requirement of exotic cows. The significant relationship between farmers' borrowing status and total variable cost reflected the fact that complementary inputs were often given in kind. On the other hand, no significant relationship was found between total input cost and liquidity constraint condition, which suggested that farmers' borrowing status was more important than constraint condition. Similar relationships were found between average expenditure and concentrates per TLU.

While the study showed that smallholder dairying was a profitable activity, the lack of any significant differences in performance between liquidity constrained and non-constrained farmers suggested that many factors other than farmers' liquidity position were important in explaining differences in performance. For example, donor intervention, which provided in-calf heifers and supplementary feed, was important in explaining some of the observed differences. Also herd size was limited more by feed availability than borrowing status or liquidity constraint condition.

Chapter 6 Impact of liquidity and credit on smallholder dairy production: Application of a switching regression model

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6.1 Introduction

In the country case studies presented in the earlier chapters, diary farmers were found to be either borrowers or non-borrowers, and both groups contained liquidity constrained and non-constrained farms. They also have shown varying degree of adoption and use of dairy technologies and inputs. From partial productivity analyses, differences in productivity among different groups of farms were also observed. In this section, the results of an econometric analysis are presented to explain the significance of these differences.

Economic theory suggests that farmers facing binding capital constraints would tend to use lower levels and combinations of inputs than those whose production activities are not limited by capital constraints. Access to credit can facilitate levels of input use closer to their potential levels when capital is not a constraint. Production loans from financial institutions can, therefore, lead to higher levels of output per farm and yield given fixed resources such as land. Policy makers and financial institutions however need to accurately assess the magnitude of the expected gains in productivity resulting from the allocation of agricultural credit. If the marginal contribution of credit to farm productivity is zero or relatively small then re-allocation of credit to other activities or sectors with higher marginal productivity may actually lead to an improvement in the welfare of society.

This study examines the impact of credit on milk productivity, defined as milk output per farm, on smallholder dairy farms in the East African highlands using data from Ethiopia and Kenya.[16] These two countries provide useful insights into the potential for peri-urban dairy development in this region because of the growing importance of peri-urban dairy activities in these countries and their favourable climatic conditions which makes them ideal for dairy production (ILCA, 1995). To test the relationship between credit and milk productivity, an approach is used which recognizes that disequilibrium may exist in household demand for or supply of credit. It is postulated that borrowers and non-borrowers are not homogeneous. In this study farmers were considered liquidity constrained if they already had a loan and yet expressed willingness to borrow more at current interest rates or they did not borrow because their request for a loan was not approved, there was no formal or informal lender to lend them,

or they feared borrowing. Some farmers who reported that there were no lenders self selected themselves out of credit markets on the assumption that they were not eligible to borrow while those who reported that they feared borrowing were considered to be risk averse to borrowing.

16. The data from Uganda were not available in a form suitable for similar analysis.

6.2 Sources and use of credit by livestock farmers in Ethiopia and Kenya

Cross-sectional surveys were conducted on a sample of smallholder dairy producers in Selale and Debre Libanos *awrajas* (administrative units similar to a district) in Ethiopia and Kiambu district in Kenya. These areas were identified as Livestock Production Zones (LPZ) with a history of smallholder dairying and credit activities. The sample comprised 74 households in Ethiopia and 94 households in Kenya. For the most part these farms were characterized as peri-urban dairy or mixed livestock farms. Dairying is an integral component of these farms and household resource allocation and management decisions reflected the diversified nature of the production system. Data on household characteristics, resource endowments, milk production, milk disposal, input use, input cost, revenue, and credit transactions were collected by structured questionnaires between 1993 and 1994. Descriptive statistics on these have been reported in Chapters 3 and 4. Some highlights of the results are given below.

Sample livestock farmers in this study received credit from both formal and informal lenders. In the Ethiopia sample 48 percent of farmers reported receiving credit form both formal and informal sources. Of those who borrowed 64 percent had loans from commercial banks while 36 percent had loans from informal sources such as savings clubs, friends and relatives. Bank loans were usually given in cash with an average repayment period of six years payable in fixed installments. Development agencies and service cooperatives recommended most farmers who received bank loans.

Over two thirds of farmers who received bank loans were classified as liquidity non-constrained. These farmers tended to receive larger loans compared to liquidity constrained farmers. The average size of bank loans to liquidity non-constrained farmers was EB1151 while that to liquidity constrained farmers was EB 724 (1 US$ = EB 6.25 at the time of the survey). About 40 percent of liquidity constrained farmers reported that the amount of loan they received at the going interest rate was less than what they requested. In contrast only 10 percent of liquidity non-constrained farmers reported receiving a smaller amount of loan than they requested.

The most important use of formal credit farmers reported was purchase of dairy cows. Over 75 percent of farmers who received credit from commercial banks used loans to purchase crossbred dairy cows. Of these about 80 percent were classified as liquidity constrained.

In Kenya 38 percent of the farmers in the study reported receiving loans from formal and informal sources. Formal institutions such as commercial banks and cooperatives were the most important sources of credit. Of all borrowers 67 percent obtained loans through cooperatives and 20 percent through commercial banks. Cash loans accounted for over 90 percent of credit disbursed with an average duration of 3 years.

About half of the borrowers who received credit from formal sources were classified as liquidity constrained. Similar to the Ethiopian sample, liquidity non-constrained farmers reported receiving larger loans compared to liquidity constrained farmers. The average size of loan to liquidity non-constrained farmers was Ksh 23120 (1 US$ = Ksh 32.22 at the time of the survey) compared to Ksh 15085 to liquidity constrained farmers. Fifty seven percent of liquidity constrained farmers reported receiving a smaller loan than they requested while 37 percent of liquidity non-constrained farmers reported receiving smaller loans than they

requested.

Relatively more borrowers irrespective of their liquidity constraint status used loans from formal institutions for purposes other than purchasing dairy cows. When all uses of loans are considered 38 percent of liquidity constrained farmers and 43 percent of liquidity non-constrained farmers reported that loans were used to purchase dairy cows.

6.3 Switching regression model of impact of credit on milk productivity

Some of the sample sites used in this study have a history of project interventions that promoted dairy development and credit activities. One would expect that the most productive farmers in the sample areas were likely to be project beneficiaries who have had access to credit and improved inputs that enhance farm output. The selection criteria used in the study did not necessarily exclude farmers who were project beneficiaries; therefore some degree of bias might have been created in the sampling process.

A switching regression model is used to correct for possible sample selection bias which may arise from other interventions that provide multiple services to farmers in addition to credit (Lee, 1978; Madalla, 1983). Empirical application of this model to agriculture includes studies by Pitt (1983), Feder *et al*. (1990), Goetz (1992), Fuglie and Bosch (1995). The two stage switching regression model applied in this study uses a probit model in the first stage to determine the relationship between farmers' liquidity constraint condition and a number of socioeconomic and credit variables. In the second stage separate regression equations are used to model the production behaviour of groups of farmers conditional on a specified criterion function.

The liquidity constraint condition of the i^{th} farmer is described by an unobservable excess demand function for credit, I^*, that is postulated to be a function of a vector of exogenous household socioeconomic, herd characteristics, and credit variables. The relationship between excess demand for credit and the vector of explanatory variables is specified as:

$$I^* = \delta' Z_i + u_i \quad (1)$$

where Z is vector of exogenous variables , δ is a vector of parameters and u_i is a random disturbance term that is distributed with zero means and variance, σ^2.

The excess demand function for credit is not observed but responses from the survey is used to determine those households whose productive activities are constrained or not constrained by liquidity. Households are liquidity constrained if the demand for credit exceeds the supply of credit, that is, $I^* > 0$. These responses are used to define a criterion function which is an observable dichotomous variable I:

where $I = 1$ iff $I^* = \delta'' Z_i + u_i \geq 0$ (2)

$I = 0$ otherwise

Probit maximum likelihood estimation is used to estimate the parameter δ in equation (2). It is assumed that var $(u_i) = 1$ since δ is estimable only up to a scale factor.

Following Feder *et al*. (1990) the production behaviour of the two groups of farmers is modeled by reduced form equations specified by:

$$Y_{1i} = \beta_1' X_{1i} + u_{1i} \text{ iff } I = 1$$

and (3)

$$Y_{21} = \beta_2' X_{2i} + u_{2i} \text{ iff } I = 0$$

where X_{1i} and X_{2i} are vectors of exogenous variables, β_{1i} and β_{2i} are vectors of parameters, and u_{1i} and u_{2i} are random disturbance terms. Y_{1i} and Y_{2i} represent output supply functions for credit constrained and credit non-constrained farmers respectively.

Application of Ordinary Least Squares (OLS) technique to estimate the parameters β_1 and β_2 in equation (3) yields inconsistent estimates because the expected value of the error term conditional on the sample selection criterion is non-zero (Madalla, 1983). The random disturbance terms u_{1i}, u_{2i} and u_I are assumed to have a trivariate normal distribution with zero mean and a non-singular covariance matrix.

Maximizing the bivariate probit likelihood function for this model is feasible but time-consuming (Madalla, 1983). Therefore, following Lee (1978) a two-stage estimation method is used to estimate the system of equations in (2) and (3). The conditional expected values of the error terms, u_{1i} and u_{2i} in equation (3) are:

$$E(u_{1i}|u_i \leq \delta' Z_i) = E(\sigma_{1u} u_i|u_i \leq \delta' Z_i)$$

$$= \sigma_{1u} \frac{\phi(\delta' Z_i)}{\Phi(\delta' Z_i)}$$

and

$$E(u_{2i}|u_i \geq \delta' Z_i) = E(\sigma_{2u} u_i|u_i \geq \delta' Z_i)$$

$$= \sigma_{2u} \frac{\phi(\delta' Z_i)}{1 - \Phi(\delta' Z_i)}$$

where ϕ and Φ are the probability density function and the cumulative distribution function of the standard normal distribution respectively. The ratio ϕ/Φ evaluated at $\delta' Z_i$ for each I is the inverse Mills ratio.

For convenience define:

$$\lambda_{1i} = \phi(\delta' Z_i)/\Phi(\delta' Z_i)$$

and (4)

$$\lambda_{2i} = \phi(\delta' Z_i)/[1 - \Phi(\delta' Z_i)]$$

These terms are included in the specification of equation (3) to yield:

$$y_{1i} = \beta_1' X_{1i} + \sigma_{1u} \lambda_{1i} + \_1i \text{ , if } I = 1 \quad \text{and} \quad (5)$$

$$y_{2i} = \beta_2' X_{2i} + \sigma_{2u} \lambda_{2i} + \_2i \text{ , if } I = 0$$

where $\acute{\varepsilon}_{1i}$ and $\acute{\varepsilon}_{2i}$, the new residuals have zero conditional means. These residuals are, however, heteroscedastic. Therefore, estimating equation (5) by weighted least squares

(WLS), rather than OLS, would give efficient parameter estimates.

Thus, the two stage estimation procedure that is used to estimate the model proceeds as follows. In the first stage probit maximum likelihood method is used to obtain estimates of δ from equation (2). By substituting the estimated values of δ for δ estimates are obtained for λ_{1i} and λ_{2i} from equation (4). In the second stage, equation (5) is estimated by WLS using the estimated values of λ_{1i} and λ_{2i} as instruments for λ_{1i} and λ_{2i} respectively.

6.4 Variables used in the models and related hypotheses

Table 1 shows the description of the variables used in the regression model. Descriptive statistics for relevant variables are shown in Table 2. For the most part the same variables were used in the Ethiopia and Kenya model. However some of the variables used in one model could not be used in the other because the information was not available. For example, farm size and family size were highly correlated in Ethiopia as land was nationalised and distributed according to the size of the family. Therefore, farm size was not used as a variable in Ethiopia. Also farmers did not keep exotic cows in Ethiopia because government policy made them inaccessible. To ensure that the statistical results were representative of the populations from which the samples were drawn, all continuous variables were weighted by total herd size in the samples.

Table 6.1. *Description of variables.*

Variable	Type	Description
AGE	Continuous	Age of household head in years
SEX	Binary	Sex of household head: 1 if household is male 0 otherwise
EXP	Continuous	Farmer's experience in livestock farming in years
FAMSIZE	Continuous	Family size
DEP	Continuous	The ratio of children to adults in the family
EDUC	Binary	1 if the farmer has formal education and 0 otherwise
LSTRG	Binary	Farmer's attendance at livestock training:1 if the farmer had attended and 0 otherwise
HSIZE	Continuous	Total herd size in TLU
MLBC	Continuous	Number of local breed milking cows
MCBC	Continuous	Number of cross-bred milking cows
MEXC	Continuous	Number of exotic breed milking cows
TOTMLK	Continuous	Total quantity of milk produced in survey period
FRMSZ	Continuous	Farm size in hectares
SITE	Binary	1 if the farmer is in Selale and 0 otherwise for Ethiopia; 1 if the farmer is in Githunguri and 0 otherwise for Kenya.
TOTVC	Continuous	Total expenditure on variable inputs
GRSRV1	Binary	1 if gross revenue is greater than or equal to average and 0
GRSRV2	Binary	otherwise 1 if gross revenue is less than average and 0 otherwise
LOAN	Binary	1 if the farmer is borrower and 0 otherwise
RPAY	Binary	Loan repayment: 1 if the farmer makes scheduled repayments and 0 otherwise
SEL	Binary	1 if the farmer is liquidity constrained and 0 otherwise

Table 6.2. *Descriptive statistics for explanatory variables.*

Variable name	Ethiopia		Kenya	
	Mean	Standard deviation	Mean	Standard deviation
AGE	–	–	54.532	12.587
SEX	0.959	0.194	0.723	0.450
EXP	23.419	13.282	–	–
FAMSIZE	–	–	3.617	2.392
DEP	3.824	1.666	–	–
EDUC	0.662	0.426	0.851	0.358
LSTRG	0.284	0.454	0.330	0.473
HSIZE	35.051	14.524	6.273	3.693
MLBC	1.973	0.844	0.06	0.23
MCBC	1.838	1.007	2.192	1.050
MEXC	–	–	1.894	0.921
TOTMLK	2200	1255.7	3253.4	2709.5
FRMSZ	–	–	2.814	2.195
SITE	0.689	0.466	0.457	0.501
TOTVC	315.85	298.62	8245.7	8595.8
GRSRV1	0.432	0.499	0.117	0.323
LOAN	0.486	0.503	0.383	0.489
RPAY	0.216	0.414	0.309	0.464

Source: ILRI survey results

The binary dependent variable in the first stage probit equation is farmers' liquidity constraint condition. The explanatory variables comprised both continuous and binary variables. Household characteristics included the age, sex, educational status of the household head, the number of years the household head had spent in farming, participation of the household head in livestock training or seminars, and family size. The age and number of years spent in farming is used as proxy variables for experience in livestock farming. Attendance at livestock training and seminars is used as a proxy for improved management or animal husbandry practices because farmers receive training in various aspects of herd management, feeding and feed production strategies and disease control at these sessions.

Household resource endowment is measured by the size of the livestock herd in Tropical Livestock Units, TLU,[16] and farm size. A site variable is included in the model to capture differences in production resources such as farm size and grazing land between the various locations in Ethiopia and Kenya. Economic variables are represented by total expenditure on variable inputs and a binary variable, which measured whether farmers' gross revenue from farming, was greater or less than the average gross revenue for the sample. Credit variables included whether a farmer had an outstanding loan during the survey period and their loan repayment record.

16. A TLU is the standard unit by which livestock of different species are compared (for details, see chapter 3).

The dependent variable in the second stage regression is the log of total volume of milk output per farm in one year measured in liters. All other continuous explanatory variables were expressed in logs. Since the coefficients of the regression equations are estimates of partial milk production elasticities, the larger the coefficient the higher the response of milk

productivity to marginal changes in input use. Negative coefficients indicate that milk productivity actually declines as the level of input increases.

The explanatory variables representing household characteristics were, for the most part, identical to those in the first stage probit regression. Farmers' age and number of years spent in farming is used as proxy for farmers' experience. No *a priori* sign is expected on the experience variable because it is both possible that older farmers with more experience in dairying are more likely to recognize the gains from adoption of improved dairy technologies as well as being more conservative and less likely to adopt improved dairy technologies. Attendance at livestock training and seminars is hypothesised to be positively correlated with milk output per farm because farmers who had acquired specific livestock management training are expected to be better farm managers. Herd variables in the regression equations included the number of local, crossbred and exotic breed milking cows in the dairy herd. The number of crossbred and exotic milking cows are expected to be positively correlated with milk output per farm because these cows have genetically higher levels of milk production potential compared to local breed cows. The number of crossbred and exotic dairy cows is used as proxy for the impact of credit on smallholder dairy farms because most farmers used formal credit to purchase these cows. Total expenditure on variable inputs is expected to have a positive influence on milk productivity. Surveys in Ethiopia and Kenya indicated that feed costs were the most important component of total variable cost. It is hypothesized that farmers with relatively high expenditure on variable inputs are more likely to practice better nutrition management involving, among other things; use of purchased supplementary feeds. A binary variable indicating whether farmers' gross revenue were greater than, equal to, or less than the sample average is used as a proxy for farmers' liquidity position. The hypothesis here is that farmers with access to higher levels of liquidity have greater ability to purchase productive inputs that are likely to improve milk productivity. The proxy variable measuring farmers' unobservable liquidity position is likely to cause endogeneity problems in the second stage estimation because current income was used to construct this variable. This problem is not considered to be serious in this case because of the lag between current income and milk production. Assuming that the disturbances are uncorrelated the proxy variable therefore is not likely to be contemporaneously correlated with the disturbance. One possibility for resolving the likely endogeneity problem is to discard the proxy for the unobservable liquidity regressor. But this also creates bias due to omitted variable problem. Following McCallum (1972) and Wickens (1972) the proxy variable for farmers' liquidity status is maintained in the regression equations on the grounds that the resulting asymptotic bias is less with using a poor proxy than omitting the unobservable regressor.[17]

> 17. The empirical results did not change significantly when separate regression were run with and without the proxy variable.

The second stage WLS regression did not include the two credit variables representing whether a farmer had an outstanding loan and farmers' loan repayment record. The maintained hypothesis is that these variables are not likely to directly influence farm level milk output. Thus, the model is identified because there is at least one explanatory variable in the first stage probit regression that is not included in the second stage WLS regression (Maddala, 1983).

6.5 Results and discussion

Table 3 shows maximum likelihood estimates of the probit model for Ethiopia and Kenya. Marginal effects indicate the effect of one unit change in an exogenous variable on the probability that a farmer was liquidity constrained. These were estimated by $\phi(\delta Z)$, calculated at the mean value of the regressors (Madalla, 1983). Marginal effects were estimated for continuous variables only because they may not be meaningful for binary variables (Greene,

1990).

Table 6.3. *Probit model for farmers' liquidity7 constraint condition.*

Variable name	Ethiopia		Kenya	
	Estimated coefficient	Marginal probability	Estimated coefficient	Marginal probability
AGE	–		–0.018025* (–3.1367)	–0.0153
SEX	–0.39257 (–0.3765)		4.4456* (2.8559)	
EXP	–0.00051 (–0.8391)	–0.0003	–	
FAM.SIZE	–		0.046844 (1.6009)	0.0266
DEP	–0.21737 (–0.6664)	–0.173	–	
EDUC	–0.11159 (–0.26503)		–2.5310* (–2.9959)	
LSTRG	0.57058 (1.0600)		2.6230* (3.0552)	
HSIZE	–0.05254* (–1.9445)	-0.051	0.76912* (2.4913)	0.7691
FRMSZ	–		0.011175 (0.55986)	0.0058
SITE	–0.69025* (–1.7895)		0.52185 (–1.0513)	
TOTVC	–0.000009 (–0.4026)	-0.0000045	–0.000027 (–0.85652)	-0.000016
GRSRV1	–0.01647 (–0.0390)		–0.26320 (–0.26300)	
LOAN	–0.50879 (–0.8735)		5.2325* (3.0786)	
RPAY	1.0441 (1.6442)		–2.3136 (–1.6893)	
CONSTANT	2.7447* (2.1472)		–4.1559* (–2.9832)	
Likelihood ratio test	29.9060		67.1595	
Percentage of correct predictions	0.86		0.88	

Figures in parenthesis are asymptotic t-ratios * Significant at 0.1 level.

Goodness-of-fit measures indicated that the estimated models fitted the data reasonably well. The choice of explanatory variables correctly predicted farmers' liquidity constraint condition for 86% of the observations in Ethiopia and 88% of the observations in Kenya. Likelihood ratio tests indicated that slope coefficients were significantly different from zero at 5% level of significance in both samples.

There was no relationship between farmers' borrowing status and their liquidity constraint condition in Ethiopia. However borrowing status was significantly related to farmers' liquidity

constraint condition in Kenya. One explanation for the differential impact of borrowing as an important determinant of farmers' liquidity constraint condition in Ethiopia and Kenya is the differences in the effectiveness of institutional systems of credit delivery in the two countries. Even though both countries relied on co-operatives to deliver credit to smallholder farmers those in Kenya have had more success reaching smallholder farmers compared to Ethiopia. The total flow of institutional credit from various institutional credit sources to smallholder dairy producers in Ethiopia has been too small to make an impact on dairy production because credit policies and the credit delivery system discriminated against these producers (Tilahun, 1994). In contrast Kenya's dairy co-operatives were the most important source of credit for smallholder producers. These observations are consistent with our survey results which showed that 67% of borrowers in Kenya obtained loans from cooperatives while the corresponding proportion in Ethiopia was less than 30%. The results therefore suggest that the functioning and effectiveness of credit delivery systems in different countries is perhaps one of the most important determinants of smallholder farmers' credit constraint condition because they largely determine their access to additional liquidity.

The differences in importance of borrowing status on farmers' liquidity constraint condition in the two countries also suggests that there is no unambiguous relationship between farmers' borrowing status and their liquidity constraint condition. This finding provides further support for the hypothesis that borrowers and non-borrowers are not homogenous with respect to their demand and supply of credit because it is possible to have both liquidity constrained and non-constrained farmers among borrowing and non-borrowing households.

Herd size was significantly related to farmers' liquidity constraint condition in Ethiopia and Kenya. The coefficient on herd size was negative in the Ethiopia equation but positive in the Kenya equation. Hence, liquidity constrained farmers were more likely to have smaller herd sizes in Ethiopia while liquidity non-constrained farmers were more likely to have smaller herd sizes in Kenya. Although liquidity non-constrained farmers tended to have smaller herds in Kenya, these comprise mainly exotic and crossbred cows with higher genetic potential for milk production compared to local breed cows. Total expenditure on variable inputs was not significantly related to farmers' liquidity constraint condition in either Ethiopia or Kenya. This finding is consistent with survey results where farmers reported using relatively small quantities of purchased variable inputs. Moreover, for those farmers who purchased variable inputs very few reported using credit for that purpose. Because the purchase of variable inputs was usually made from own resources and relatively small amounts of money were spent on those purchases compared to outlays for investments in dairy cows, total expenditure on variable inputs was not relevant in determining the liquidity constraint condition of farmers. Site was significantly related to farmers' liquidity constraint condition in Ethiopia but not in Kenya. This variable probably captures most of the variation in grazing area. In Ethiopia sample farmers relied mostly on open access grazing therefore variation between sites was important. Areas with larger open access grazing area were more likely to have less liquidity constrained farmers because cash needs for purchased feed were relatively less. On the other hand in Kenya most farmers practiced stall-feeding and hence had to rely on purchased feed. Under these circumstances variation in open access grazing was less likely to be an important determinant of farmers' liquidity constraint condition. Household characteristic variables such as age, sex, education and attendance at livestock training were significantly related to farmers' liquidity constraint condition in Kenya but not in Ethiopia. The importance of household specific characteristic in one location and not the other suggests that there is no unambiguous relationship between these characteristics and liquidity constraint condition. Therefore the relationship between these variables and farmers' liquidity constraint condition are specific to the location. To the extent that herd size and site were indicative of farmers' level of resource endowments, these findings suggest that only the resource endowment structure was important in explaining the probability of their liquidity constraint condition in Ethiopia while both farmers' resource endowments structure and household characteristics

were important determinants of liquidity constraint condition in Kenya.

The marginal effects, measured by marginal probabilities in Table 3, indicate that an additional unit of labor will have the largest impact on the probability of farmers' liquidity constraint condition in Ethiopia while an additional unit of livestock will have the largest impact on the probability of farmers' liquidity constraint condition in Kenya. The differences in marginal effects in the two locations suggest that while resource endowments might be important in determining the probability of farmers' liquidity constraint condition there are likely to be wide variations in the importance of specific resources in different locations.

Reduced form WLS coefficient estimates of second stage switching regression models for milk output per farm are shown in Tables 4 and 5. In Ethiopia the number of local and crossbred milking cows had positive coefficients and were significant in explaining variations in milk production on liquidity constrained farms while only crossbred milking farms were important determinants of milk output on liquidity non-constrained farms. However, an additional crossbred milking cow contributed about five times as much milk output per farm compared to an additional local breed milking cow on liquidity constrained farms. Total expenditure on variable inputs was an important determinant of milk output on liquidity constrained farms but not on liquidity non-constrained farms. This suggests that for liquidity non-constrained farmers additional expenditure on variable inputs was not as much a constraint on milk production as additional investments in crossbred cows. Improved management through livestock training and seminars did not significantly influence milk output on credit constrained farms but it was important on liquidity non-constrained farms. This implies that efforts to increase milk output through improved management training might not be effective when farmers are constrained by liquidity. Improved livestock training therefore becomes more valuable under less constrained circumstances.

Table 6.4. *Reduced form WLS estimated coefficients of second stage switching regression model for*
milk output per farm: Ethiopia.

Variable name	Estimated coefficient	
	Credit constrained	Credit non-constrained
SEX	–0.01220 (–0.0225)	–0.19135 (–0.5035)
EXP	–0.14618 (–0.7953)	–0.23056 (–1.322)
DEP	–0.02224 (0.1307)	–0.08710 (–0.6207)
EDUC	0.34097 (–1.300)	–0.37136* (–2.167)
LSTRG	0.27591 (0.9933)	0.40361* (2.463)
MLBC	0.14536* (2.279)	0.01594 (0.2788)
MCBC	0.63260* (2.043)	0.38519* (2.384)
SITE	–0.16004 (–0.7852)	–0.31455 (–1.213)
TOTVC	0.18051* (2.235)	0.00055 (0.0073)
GRSRV1	0.33236	0.42436*

	(1.211)	(2.527)
LAMBDA	0.21403 (0.6100)	0.63889 (1.721)
CONSTANT	7.1874* (6.099)	11.644* (6.340)
ADJUSTED R^2	0.5707	0.5704

Figures in parenthesis are t-ratios ** [8] Significant at 0.1 level

Table 6.5. *Reduced form WLS estimated coefficients of second stage switching regression model for milk output per farm: Kenya.*

Variable name	Estimated coefficient	
	Credit constrained	Credit non-constrained
AGE	0.02967* (1.871)	0.01647 (1.867)
SEX	0.05813 (0.0987)	0.00751 (0.0335)
FAMSIZE	–0.55513* (–2.213)	-0.09445 (–0.7088)
EDUC	–0.86637 (–1.378)	-0.18948 (–0.5949)
LSTRG	0.38647 (0.9896)	-0.44151* (–2.024)
MLBC	1.1447* (2.948)	0.21100 (0.7287)
MCBC	1.6145* (5.548)	0.86926 (5.794)
MEXC	0.33441* (2.497)	0.010054 (1.266)
FRMSZ	–0.40681* (–2.003)	0.02530 (0.2204)
TOTVC	–0.007916 (–0.0581)	0.02094 (0.3504)
GRSRV1	1.3096* (2.431)	0.45487 (1.665)
LAMBDA	0.17213 (0.5938)	0.01889 (0.0504)
CONSTANT	6.2909* (4.241)	6.7124 (8.460)
ADJUSTED R^2	0.7684	0.5311

Figures in parenthesis are t-ratios.

In Kenya the regression equations for liquidity constrained farmers indicated that most of the variation in milk output per farm was explained by the number of local, crossbred and exotic milking cows. In contrast, only crossbred milking cows were important determinants of milk output on liquidity non-constrained farms. Similar to the Ethiopia result, the number of

crossbred milking cows was the most important determinant of milk output compared to either local or exotic milking cows. An additional crossbred milking cow contributed about fives times as much to milk output per farm compared to an additional exotic milking cow on liquidity constrained farms while on liquidity non-constrained farms, local and exotic cows were not even significant determinants of milk output. This finding suggests that despite the fact that the genetic potential for milk production is higher for exotic cows, their on-farm performance can be substantially low. A likely explanation for the differences in on-farm performance of crossbred and exotic dairy cows is the greater susceptibility of exotic cows to environmental stress such as higher incidence of disease risk and relatively high managerial requirements. Total expenditure on variable inputs did not influence milk production on either liquidity constrained or non-constrained farms probably because relatively small amounts of purchased supplementary feed were used on these farms. Improved management skills through livestock training and seminars significantly influenced milk production on liquidity non-constrained farms although the negative coefficient on this variable was not intuitively appealing. Here it appears that knowledge of improved management skills does not translate into increases in farm level milk production. While this may be true it is also likely that this unexpected result is due to other confounding factors in the data set or the relatively small number of observations on farmers who had attended livestock training or seminars in Kenya. The coefficient for lambda was not significant in any of the regression equations. This suggests that the sample did not suffer from serious sample selection bias and that direct estimation of the model by OLS would have yielded unbiased estimates.

6.6 Conclusions and implications

Smallholder dairy farmers in peri-urban areas of Ethiopia and Kenya are in an ideal position to satisfy growing urban demand for dairy products. To be able to do so these farmers must increase dairy productivity. This study provides additional evidence that credit from formal financial institutions enable smallholder producers to draw upon finances beyond their own resources and take advantage of productive opportunities. The results indicated that smallholder livestock producers in both Ethiopia and Kenya, particularly those who are constrained by liquidity, used credit from formal sources to invest in crossbred and exotic breeds of dairy cows with higher milk production potential. The marginal contribution of crossbred dairy cows was the most important determinant of milk productivity for all categories of farmers in both samples. Since formal credit facilitates investment in crossbred cows additional access to credit by smallholder livestock producers enhance farm level milk productivity which could be translated into substantial increases in aggregate domestic milk output in these countries.

The study shows that the marginal contribution of credit to milk productivity was different among liquidity constrained and non-constrained farmers. Using investment in crossbred dairy cows as a proxy for the use of credit, the results imply that the marginal contribution of credit to milk productivity is relatively high on liquidity constrained farms compared to liquidity non-constrained farms. A one- percent increase in credit used to purchase crossbred dairy cow leads to 0.6 percent increase in milk productivity on liquidity constrained farms and 0.4 percent increase on liquidity non-constrained farms in Ethiopia. In Kenya a one percent increase in credit for investment in crossbred dairy cow leads to 1.6 percent increase in milk productivity on liquidity constrained farms and 0.9 percent increase on liquidity non-constrained farms. Similarly total expenditure on variable inputs significantly influenced milk production on liquidity constrained but not on liquidity non-constrained farms implying that the marginal productivity of working capital is different on these farms. These differences in the marginal contribution of credit to milk productivity among liquidity constrained and non-constrained farmers suggest that carefully targeted livestock credit schemes to those most in need are likely to have important equity and efficiency payoffs. Apart from contributing to milk productivity and income generation, keeping crossbred cows instead of the indigenous local

breed cows allows farmers to hold smaller herds of more productive cows. The implication of this is that there would be less pressure on the resource base because stocking rates are likely to be reduced if farmers are encouraged to replace large herds of less productive local cows with smaller herds of more productive crossbred cows.

While investments in additional crossbred dairy cows has the greatest potential for smallholder milk production, the full milk production potential from adoption of improved dairy technologies is not being realized. This is attributed, in part, to the fact that variable input use, as measured by expenditure on variable inputs and management practices, has not had much influence on milk production on smallholder dairy farms. This result is consistent with results from the survey in which few farmers reported using credit for the purchase of variable inputs such as feeds. In Ethiopia many farmers openly graze their herds and few use very small quantities of supplementary feed or health inputs. In Kenya where stall-feeding is common, use of purchased inputs is still relatively low compared to optimal levels. In both cases use of purchased supplementary inputs at sub-optimal levels are likely to have significant effects on animal nutrition. Farmers consistently rated lack of liquidity higher than availability of inputs in explaining relatively low levels of utilization of purchased supplementary inputs. Reducing the liquidity constraint on use of supplementary inputs through making credit available for working capital can encourage higher levels of use and facilitate their optimum use. But the relative returns to investment in supplementary inputs have to be attractive for farmers to make the necessary investment given the alternative uses of scarce capital. Careful economic analysis is therefore necessary to assess the relative returns to farm level investments over a whole range of investments that farmers are likely to be making.

The results suggest that improved management skills through livestock training and seminars can positively influence milk productivity on liquidity non-constrained farms but not on liquidity constrained farms. Efforts to increase milk output through improved management skills might not be effective when farmers are constrained by liquidity. Thus dairy development programmes with training components would only realize payoffs to their investments in training after the liquidity needs of farmers have been satisfied.

This study provides additional evidence on the importance of accurately assessing farmers' demand for credit. To do this policy makers and financial institutions need to go beyond whether farmers are borrowers or non-borrowers to take account of their resource endowments and household characteristics. An accurate assessment of farmers' liquidity constraint condition is important for credit policy because it provides useful insights into the circumstances under which credit is likely to have the greatest impact. Returns to investments in credit programmes would yield the greatest returns when there is differential targeting of credit by location. Additional credit can have the desired impact using existing institutional arrangements where there is a functioning credit delivery system which smallholder farmers have access to. On the other hand if credit delivery channels are not functioning or are not effective in reaching smallholder farmers, substantial gains could be obtained from investments in credit delivery institutions which are accessible to farmers.

It is important to recognize that borrowers are not homogeneous in terms of their need for credit and that the marginal productivity of credit would be different even among different borrowers. Policy makers and financial institutions should carefully target those farmers most in need of additional capital in order to obtain the greatest impact from credit. There is also an additional need for understanding the use to which credit is being put. The full potential of credit on smallholder dairy production cannot be realized when credit is used only for investment capital. Credit for working capital, such as for the purchase of feed and veterinary services, are also important if smallholder farmers are to achieve the potential levels of milk production that is possible under their circumstances.

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