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Smallholder Dairy Intensification in the Ethiopian Highlands:

Consequences for Intra-household Resource Allocation and Distribution of Benefits

- with Special Regard to Child Nutrition

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Summary

That agriculture and human nutrition are linked is evident, but these links are often more complex than generally assumed. Amartya Sen (1988) states, that food-security is far more than merely increased agricultural production. With his expression of the term “food entitlement”, he points to the fact that it is foremost the lack of access to food, thus poverty, which is the actual cause of food-insecurity. Provided that a favorable marketing environment exists, intensification and commercialization of agricultural production can serve as vital means to raise smallholder income.

In the peri-urban region of the Ethiopian capital Addis Ababa the “Peri-Urban Dairy Technologies Project” has enabled smallholder dairy farmers to realize higher farm incomes through the intensification and commercialization of dairy production. One of the objectives of the project is to improve the unsatisfying state of child nutrition in the project region, which is particularly characterized by vitamin A deficiency. A pre-assessment in the project region documents a very high number of children with eye disorders that are regarded an apparent symptom of vitamin A deficiency. Increased dairy production can directly improve the state of child nutrition, if it raises subsistence milk consumption. It is more reasonable, however, to anticipate a rather indirect effect on the nutrition situation, because increased milk availability is more likely to encourage poor smallholders to increase their income through dairy sales.

Research investigating the relationship between agricultural change and human nutrition confirms the complexity of this relationship and documents that increases in smallholder income generally lead to improvements of household food consumption. However, more differentiated approaches show that the magnitude of the income effect on child nutrition often falls short expectations.

Micro-level economic analyses in the past reveal two shortcomings toward which research attention needs to be drawn: Increases in smallholder income do not always lead to increases in household food consumption and from improvements of the food situation of the household as the whole not all household members necessarily benefit to the same extent.

The present study examines whether child nutrition is rather directly affected by the intensification of dairy production, resulting from the consumption of more milk, or whether it is rather affected indirectly by income increases obtained from the more commercialized dairy activity. In addition, it investigates the assumption that more vulnerable household members, foremost children, do not benefit from increases in income from dairy intensification and commercialization, because women lose important income sources as a consequence of the technological change. Milking and processing, utilization and sale of dairy products has traditionally been the domain of women and they have a high degree of control over the income from the sale of dairy products. With the adoption of crossbred cows

the larger amount of fresh milk obtained from grade cattle makes it feasible to sell fresh milk to the fluid milk market. This activity is the dominion of men. The resultant acquisition of income then reverts to them, who are generally expected to have a lower propensity to provide for household food consumption.

Analytical approach and conceptual design are based on the household-farm model, including aspects of the theory of intra-household resource allocation. The study compares 40 farming households at Holetta, a periurban region of the Ethiopian Highlands, who participate in the “Peri-Urban Dairy Technologies Project” and who adopted crossbred cows and associated technologies for intensified dairy production with 40 control households who are dairy farmers using local animals and traditional practices. The empirical analysis is based on data of a very comprehensive and detailed survey of the household-farm system. The larger part of these data are obtained from ILRI (International Livestock Research Institute). They comprise information about crop and livestock production, income sources and income distribution, expenditure patterns, household food consumption including dietary composition, as well as anthropometric measurements of children from survey households. In addition the author has conducted a survey among the women of the farm households. It embraces information about formal school education, maternal nutritional knowledge, child care, the prevailing health situation, as well as availability of water and sanitation facilities in the survey region. The flow-diagram depicted in Diagram 1.3.1 illustrates the model, which guided data management and empirical analysis.

Study results show that the nutritional status of children of households participating in the “Peri-Urban Dairy Technologies Project” is noticeably better than the nutritional status of children of control households. This is reflected in the overall household food consumption of project households, that is characterized by higher expenditures for food commodities, as well as a diet more rich in quality and quantity of foods consumed. Above this, the growth parameter chosen to indicate the nutritional status of children is significantly better for project households.

The growth parameter, reflecting chronic malnutrition, measures the prevalence of stunting among pre-school children. The parameter is significantly different between the two groups of children. 47 percent of the children from control households are stunted, whereas only 26 percent of the children from participating households are stunted. Both estimates are markedly better than the country average of 64 percent stunting found in all children living in rural Ethiopia.

Study results disprove the assumption, that women lose control over traditional income sources as a consequence of dairy intensification and commercialization. It is true, that a far greater share of the additional income from dairy marketing is gained by men. Nevertheless,

women of households participating in the “Peri-Urban Dairy Technologies Project” still have three times more income than women from traditional farmers.

Study results further show, that children of households participating in the “Peri-Urban Dairy Technologies Project” consume almost three times more milk than children of control households. This leads to the conclusion, that the better nutritional status of children from project farmers is a direct effect of the dairy intensification.

The strong positive effect of the “Peri-Urban Dairy Technologies Project”-participation on child nutrition is surprising and encouraging: Surprising, because such favorable effects have seldom been documented for other studies on smallholder agricultural commercialization and child nutrition. Encouraging, because Ethiopia is one of the countries with the worst state of child nutrition in the world and improvements in this sphere should accompany any development activity.

The positive effects of the “Peri-Urban Dairy Technologies Project” on smallholder welfare, confirmed by the study analysis, should consequently result in further promotion of smallholder dairy intensification in the Ethiopian Highlands. Nevertheless, this conclusion has to be made with caution for two reasons: For one reason, because it is uncertain whether project farmers are facing ‘real world situations’. It should secondly be noted, that smallholders retain relatively large shares of milk for home consumption. This is rather atypical for dairy intensification schemes. Usually a nutrition effect would not be anticipated to occur as a direct consequence of increased dairy consumption, but would occur as an income effect, allowing for increased staple consumption from favorable terms of trade between dairy products and cereals. A study examining the market situation and prices that smallholders are facing in the survey area would be required to further investigate this atypical result.

Zusammenfassung

Der Zusammenhang zwischen landwirtschaftlicher Erzeugung und menschlicher Ernährung liegt auf der Hand, ist aber komplexer als allgemein erwartet wird. Amartya Sen (1988) führt an, daß Ernährungssicherung weit mehr als gesteigerte landwirtschaftliche Produktion ist. Mit seinem Begriff des „Anrechts auf Nahrungsmittel“ verweist er auf die mangelnde Kaufkraft armer Bevölkerungsschichten als eigentliche Ursache von Unterversorgung mit Nahrungsmitteln. Unter günstigen Vermarktungsmöglichkeiten bietet die Intensivierung der landwirtschaftlichen Produktion auch für Kleinbauern die Möglichkeit, ihr Einkommen zu steigern.

Im Einzugsbereich der Äthiopischen Hauptstadt Addis Abeba bewirkt das *„Peri-Urban Dairy Technologies Project“* durch die Kommerzialisierung und Intensivierung der Milcherzeugung erhöhte Einkünfte in kleinbäuerlichen Haushalten. Ein Projektziel ist die Behebung der Mangelernährung von Kindern, die in der Projektregion insbesondere durch Vitamin A Mangel in Erscheinung tritt. Eine Voruntersuchung stellte eine hohe Zahl von Netzhautveränderungen bei Kindern fest, was ein deutliches Mangelsymptome darstellt. Gesteigerte Milcherzeugung kann direkt die Ernährungslage verbessern, wenn sie den Subsistenzverbrauch von Milch erhöht. Erwartungsgemäß ist der Einfluß auf die Ernährungslage allerdings indirekter Natur, denn die gesteigerte Milcherzeugung dient ärmeren bäuerlichen Haushalten der Einkommensbeschaffung durch den Verkauf der Milch.

Haushaltsökonomische Untersuchungen in der Fachliteratur beweisen die Komplexität dieser Zusammenhänge und dokumentieren in der Regel, daß Einkommenssteigerungen in landwirtschaftlichen Haushalten zu einer verbesserten Nahrungsmittelversorgung führen. Allerdings stellt sich bei einer differenzierteren Betrachtung heraus, daß die mangelhafte Kinderernährung nicht in dem zu erwartenden Maße behoben wird.

Haushaltsökonomische Betrachtungen in der Vergangenheit weisen zwei Defekte auf: eine verbesserte Einkommenssituation führt nicht immer zu einer verbesserten Ernährungslage und von einer verbesserten Ernährungslage für den Haushalt als Ganzes profitieren unter Umständen nicht alle Haushaltsmitglieder in gleichem Maße.

Die vorliegende Studie prüft, ob Effekte auf Kinderernährung durch direkte Ernährungsverbesserung (in Form von mehr Milch) oder durch eine Einkommenssteigerung durch den Verkauf der Milch zu erwarten sind. Außerdem untersucht sie die Vermutung, daß schwächere Haushaltsmitglieder, insbesondere Kinder, nicht in den Genuß der Einkommenssteigerung aus intensivierter, marktorientierter Milcherzeugung kommen, weil Frauen Einkommensquellen durch diesen technischen Wandel abhanden kommen. Denn während im traditionellen Betriebssystem Frauen überschüssige Milch in Form von

Verarbeitungsprodukten wie Butter oder Käse auf lokalen Märkten verkaufen, führt die Intensivierung zu einer Vermarktung der frischen Milch, die in der Regel in der Verantwortlichkeit der Männer liegt. Ob die Männer Einnahmen aus dem Verkauf der Milch in gleichem Maße für die Versorgung des Haushalts mit Lebensmitteln nutzten, ist nicht sicher.

Analytischer Ansatz und methodisches Vorgehen beruhen auf der Theorie der Betriebs-Haushalts Ökonomie und berücksichtigen dabei neuere Erkenntnisse aus dem Forschungsgebiet der Intra-Haushalts Ressourcen Allokation. Die Studie vergleicht 40 Haushalte, die Teil des *„Peri-Urban Dairy Technologies Project“* sind mit 40 Kontrollhaushalten, die kleinbäuerliche Milcherzeugung unter traditionellen Produktionsbedingungen betreiben. Die empirische Analyse beruht auf einer sehr umfassenden und detaillierten Erfassung von Daten zum Betriebs-Haushalts-System. Ein Teil dieser Daten wurde von ILRI zur Verfügung gestellt. Sie enthalten Informationen über landwirtschaftliche Produktion, Einkommen, Höhe und Struktur der Ausgaben, Lebensmittelversorgung sowie den Ernährungsstatus der Kinder der Kleinbauern. Zusätzlich zu diesen Daten hat die Autorin eine Erhebung unter den Frauen der Haushalte durchgeführt. Dabei wurden Daten zur Schulausbildung der Frauen, ihre Kenntnisse über Kinderernährung und ihre Fürsorge sowie in der Projektregion vorherrschende Krankheiten, sanitäre Einrichtungen und Wasserversorgung erfaßt. Das in Diagram 1.3.1 aufgeführte Flußdiagramm illustriert das Model, das der Analyse zugrunde liegt.

Die Studie ergab, daß der Ernährungsstatus der Kinder aus Haushalten, die am *„Peri-Urban Dairy Technologies Projekt“* teilgenommen haben, deutlich besser ist, als der Ernährungsstatus der Kinder aus den Kontrollhaushalten. Dies zeigt sich in der Ernährungslage der Projekthaushalte als Ganzes, die höhere Ausgaben für Lebensmittel haben und deren Nahrungsangebot viel reichhaltiger und nahrhafter ist. Darüber hinaus zeigt sich aber auch, daß der Indikator, der den Ernährungsstatus der Kinder widerspiegelt, für Kinder der Projekthaushalte deutlich besser ist.

Als Indikator für die Mangelernährung dient hier ein Wachstumsparameter der Kinder, nämlich die Zahl der Kinder, die für ihr Alter zu klein sind. Die Studie ergab, daß die Zahl der mangelernährten Kinder aus Projekthaushalten viel geringer ist, als die Zahl der mangelernährten Kinder aus Kontrollhaushalten.

Es zeigte sich auch, daß die Annahme, daß Frauen in Folge der Intensivierung und Kommerzialisierung Einkommensquellen abhanden kommen, nicht zu rechtfertigen ist. Es stimmt zwar, daß der größere Teil des zusätzlichen Einkommens aus der Vermarktung der Milch von den Männern verdient wird. Trotzdem haben aber auch die Frauen der Projekthaushalte dreimal mehr Einkommen als die Frauen der Kontrollhaushalte.

Die Untersuchung ergab auch, daß die Kinder der Projektbauern fast dreimal mehr Milch konsumieren als die Kinder der Kontrollbauern. Es läßt sich daraus schließen, daß ihr verbesserter Ernährungsstatus eine direkte Folge der intensivierten Milcherzeugung ist.

Der starke positive Einfluß des *„Peri-Urban Dairy Technologies Project“* auf die Ernährungssituation von Kindern ist überraschend und zugleich auch ermutigend. Überraschend, denn ein so positiver Effekt hat sich selten für andere Projekte intensivierter kleinbäuerlicher Milcherzeugung gezeigt. Ermutigend, denn Äthiopien steht mit der hohen Zahl mangelernährter Kinder als eines der Schlußlichter im weltweiten Vergleich und hat eine Verbesserung der Ernährungssituation dringend nötig. Die positive Auswirkung des *„Peri-Urban Dairy Technologies Project“* auf die Ernährungslage von kleinbäuerlichen Haushalten sollte folgerichtig die weitere Förderung intensivierter, marktorientierter kleinbäuerlicher Milcherzeugung im Äthiopischen Hochland nach sich ziehen. Diese Schlußfolgerung allerdings mit Vorsicht betrachtet werden, und zwar aus zwei Gründen: zum einen, denn es kann nicht mit Sicherheit behauptet werden, daß die Projektbauern wirklich „reale Produktionsbedingungen“ erfahren, zum anderen, weil es ein sehr untypisches Projektergebnis ist, daß die Kleinbauern relativ große Mengen ihrer Milchproduktion zum Subsistenzverbrauch nutzen. Da Kleinbauern nur über ein sehr geringes Einkommen aus dem Verkauf der landwirtschaftliche Erzeugung verfügen, wird im allgemeinen davon ausgegangen, daß sie es vorziehen, ein Luxusprodukt wie Milch am Markt gegen eine größere Menge billigerer Nahrungsmittel zu tauschen. Eine Studie, die die vorherrschenden Marktverhältnisse und Preise untersucht, könnte helfen, diesbezüglich Aufklärung zu leisten.

1 Introduction

1.1 Problem Statement and Study Background

Over the last three decades, Ethiopia has experienced the compounding effects of civil strive, drought, and famine. Food shortages and acute malnutrition were foremost concerns of public policy and international aid agencies. Today Ethiopia's rural population still suffers from severe chronic malnutrition with a high prevalence even in food surplus regions (CSA, 1992).

Children in Ethiopia are among the most malnourished in the world. They often lack sufficient amounts of protein and energy in their diet, but lately attention is also directed towards micronutrient deficiencies, such as iron, iodine, and vitamin A deficiencies (UNICEF, 1993). In the study area the prevalence rate of eye disorders caused by the deficiency of vitamin A is very high. In fact it is a multiple of twenty times the suggested critical value to be considered a public health problem by standards of the World Health Organization (West, 1994).

Poverty and malnutrition are especially obvious in rural areas of the country, where the majority of people is engaged in small scale subsistence oriented farming. This is also true for the Ethiopian Highlands, a region which is actually known for its remarkable biophysical farming potential. Optimistic considerations bear ground to speculate that Ethiopia has the potential not only to feed the whole of East Africa (Nohlen and Nuscheler, 1984). But unfortunately, the present reality is that agricultural production is relatively low. Furthermore population growth and soil degradation continuously increase pressure on the scarce land resources.

A strategy vividly advocated to support smallholder farming is the intensification of the dairy production in mixed farming systems (FAO/ILRI, 1995; Winrock International 1992; Walshe et al., 1991). Within the overall goals of reducing rural poverty, promoting rural growth, and enhancing sustainable resource use intensification aims at making small scale farming economically viable through technological change and commercialization. In the case of dairy intensification in the Ethiopian Highlands farmers need to invest capital resources to purchase upgraded cattle breeds, build sheds and provide for seeds, feeds, and animal services. Successful management of the dairy cows also requires knowledge and increased labor inputs to cultivate fodder and market the produce. The incentive for farmers to adopt this technological change are higher returns from the sale of the produce. Gains are

maintained from trade and specialization, made possible through a transformation from subsistence production to more market integration called commercialization.

Most favorable conditions for the intensification of dairy production exhibit the rural belts around urban centers, because market demand for dairy products is guaranteed and even poor infrastructure cannot impede supply of highly perishable products such as fresh cheese or milk from reaching consumers in the urban centers (Ehui et al. 1995). From this point of view it is this peri-urban location that offers the opportunity for dairy intensification and commercialization.

Demand for milk and milk products in all of Africa, especially in and around urban centers, is high and growing. Demand presently exceeds supply and is projected to increase substantially in the future due to population growth, urbanization, and further strengthening economies (Winrock International, 1992). Likewise Ethiopia exhibits a high demand for milk products, especially butter. Presently this demand can only be satisfied through the import of powdered milk and butter oil (Shapouri and Rosen, 1992). The economy is growing and on-going institutional change and favorable agricultural policy support the development of the smallholder dairy sector (Staal, 1997).

To the extend smallholder dairy intensification and commercialization is established by Ethiopia's smallholders at present, the benefits in terms of increased milk production and increased incomes are well established (Gryseels and Whalen, 1984; Shapiro and Buta, 1997). Nevertheless commercialization of subsistence oriented smallholder agricultural production remains a controversial issue. Successfully implemented development objectives such as higher farm incomes can have their pitfalls and easily obscure planners and policy makers from the fact that other welfare measures have not changed or even declined.

These are concerns regarding equity. Equity issues can be dealt with on three levels. While the urban bias - the urban population profiting more from development than rural people - and the large farmer bias - small farmers being unable to participate in structural change - are issues for some time already, the issue of equity within the household has only attracted broad attention in recent years (IFPRI,1992).

This issue is tackled by the study field of intra-household resource allocation. It is seeking to understand how rights, responsibilities, and resources are allocated among members of a household (Haddad at al., 1997). This is an attempt to "look beyond the door of the household" to comprehend the dynamic processes which lead to improvements or

impediments of the well-being of individuals. In this regard agricultural change such as intensification and commercialization are not merely technical processes. They often induce a shift of rights, responsibilities, and resources, such as land parcels, income shares or available food between household members. In sum these effects may be positive, but for individual household members they might be negative. A realistic anticipation of such changes is important so that benefits from programs and projects can be effectively realized or negative outcomes be avoided (v. Braun and Kennedy, 1994).

An operational indicator for the welfare of individual household members is child nutrition. It is proposed as indicator in this study for three reasons. The first reason is the unfortunate state of child nutrition in the study area, where vitamin A deficiency is a very serious strain to health of children. Improvements in the general welfare of households should be noticeable as improvements to child nutrition. The second reason is that, on the other hand, agricultural commercialization and intensification have continuously been called in question for their impact on child nutrition. Particularly the development of cash crop production and dairy commercialization have been repeatedly criticized for their adverse effects on child nutrition. Therefore a critical observation should take place in order to avoid these adverse effects. The third reason is the pronounced concern that opportunities latent in efficiently directed agricultural research might be forgone if nutritional goals are not made explicit (Pinstrup-Andersen et al., 1988). Furthermore, according to Gryseels and Whalen (1984) and again in FAO/ILRI (1995) the link between livestock production and human nutrition is of particular relevance in the African context.

Much of the labor demand posed on dairy producing households in the traditional crop-livestock system is supplied by women. They clean the shed, feed and milk the animals, process the milk and sell the products on the local markets. Intensification and commercialization of smallholder dairy production in the Ethiopian Highlands, while providing the advantages of higher milk outputs and increased income, increase the labor demand placed on women, but also on men (MoA/FINNIDA, 1991). Furthermore, larger amounts of milk obtained from grade cattle make it feasible to sell fresh milk to the fluid milk market. According to Gryseels and Whalen (1984) this activity is the dominion of men. The resultant acquisition of income then reverts to them, who are known to have a lower propensity to provide for household food consumption (Quisumbing et al., 1996). However, evidence regarding the consequences on individual household members' incomes, food consumption, and nutrition has been conflicting (Gryseels and Whalen, 1984; MoA/FINNIDA, 1991).

1.2 Objectives of the Study

Intensification and commercialization of traditional mixed crop-livestock farming in the Ethiopian Highlands has implications for division of labor and for relative control over income sources between male and female household members, which may change budget allocations within the household beyond the pure income effect. This study attempts to trace such effects and to quantify their impact on the consumption and nutrition effects of increased commercialization of traditional agriculture. Understanding these relationships is crucial to identifying policy options that avoid adverse effects of commercialization on consumption and nutrition in poor households and enhance positive ones.

The overall objective of the study is to assess the net effect of intensified dairy production on child nutrition.

The specific objectives of this study are to

1. investigate the change in control over income from the sale of dairy products;
2. document whether a difference is manifest between the direct effect of increased milk yield on child nutrition and the indirect effect of increased commercialization of dairy production on child nutrition;
3. identify possible constraints to improved child nutrition latent within the household and community environment: health facilities, education status of women, sanitation, hygiene.

Hypothesis

- Dairy intensification and commercialization of dairy production has an overall positive effect on child nutrition.
- Children will directly benefit (nutritional status) from intensified dairy production through higher milk availability at the household.
- Children will indirectly benefit from intensified dairy production through increased expenditure on food and health related expenditures.
- Mothers lose control over income traditionally gained from marketing of home produced butter and cheese, negatively determining child nutrition, because women are understood to have a higher propensity to provide for household calories.
- Major improvements in child nutrition are not realized if parents are uneducated, mothers do not have knowledge about nutritional requirements of their children, health facilities do not exist and sanitation and hygiene remain generally poor.

1.3 Study Approach and Overview of the Study Structure

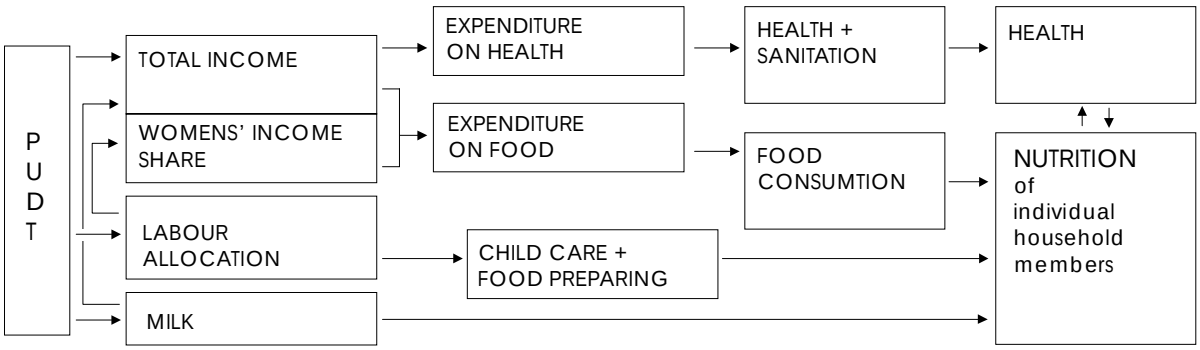
1.3.1 Approach of the Study

The study analysis generally covers two particular interests. One is, that it will capture the effects of the transition to intensified dairy production and commercialization not only at the level of the household but at the level of individual household members, namely children. But this eventual outcome - the nutritional status of children - is not the only concern. The other interest is to gain an understanding of the process which leads to that outcome. This process is manifested in a change in allocation of rights, responsibilities, and resources within the household. Naturally a study of this limited dimension can never succeed to fully satisfy the second interest mentioned. Nevertheless emphasis is given not to ignore the processes which take place within households, since they are the causing agents to improvements or impediments of individual welfare.

The analysis is guided by a framework[1], which is commonly used in a number of micro-level studies conducted in collaboration with the International Food Policy Research Institute (IFPRI) (v. Braun and Kennedy, 1994). Their basis is the theory of intra-household resource allocation. This framework conceptualizes how the various factors which are eventually determining nutritional outcomes of individual household members are related.

A simplified framework was conceptualized for the present study, depicted in Diagram 1.3.1. It highlights the factors and linkages between factors relevant to the theme under investigation. It also helped to direct survey design and data collection, as well as statistical and econometric analysis.

Diagram 1.3.1 Study framework



Compiled by the author.

[1] This framework is depicted in section 2.3.1.

A vast body of data necessary for the analysis was collected under the mandate of the International Livestock Research Institute (ILRI), the Ethiopian Institute of Agricultural Research (IAR) and the Ethiopian Health and Nutrition Research Institute (EHNRI). This covers variables comprising crop and livestock production, income sources and distribution, expenditures by household members, food consumption, and dietary composition as well as anthropometric measures.

The original approach to the survey was to additionally use qualitative data collection techniques to broaden the spectrum of data available from ILRI, IAR, and EHNRI. In the opinion of the author these techniques would have resembled a very desirable mode of acquaintance with the farmers and could have provided means to thoroughly gain an inside into farming and living conditions of the people involved in the study.

Nevertheless, various constraints limited this original outset to 20 semi-structured interviews with mothers of the households. These where accompanied by lengthy transect walks. Immediate determinants of child nutrition such as nutritional knowledge of mothers, sanitation, and infant feeding practices were not covered by the survey protocol of ILRI and EHNRI. This gap was filled by the design and implementation of an additional questionnaire addressing the mothers in the households.

The basic approach to data analysis is a cross-sectional comparison between households involved in traditional dairy production to those who adopted the technology for intensified dairy production. Exploratory and descriptive statistics including a factorial analysis have been applied.

1.3.2 Overview of the Study Structure

The following chapter 2 describes the relationship between agricultural change, income, food consumption, and nutrition outcomes. It will be explained, why this relation can be problematic, although it may appear rather straightforward at first glance. The framework which guides many recent analyses on the issues of intra-household resource allocation will be scrutinized on. This is accompanied by the presentation of research findings in the study field of agricultural change and human nutrition.

Chapter 3 attempts to draw a comprehensive picture of the overall context under which intensification and commercialization of smallholder dairying in the Ethiopian Highlands takes place. This includes the natural and socio-economic environment, but it also emphasizes on the health and nutrition situation in the country, because this relates to the chosen indicator of child nutrition in the analysis.

In Chapter 4, it is documented how empirical survey and data analysis have been conducted. The first part outlines survey design and data collection techniques. The second part describes modes of data analysis applied.

Chapter 5 presents the results of the analysis, which are discussed referring to the research findings introduced in chapter 2.

To complete the report, Chapters 6 draws conclusions on the role of intensification and commercialization of dairy production in smallholder mixed farming systems in the Ethiopian Highlands plays in order to enhance the welfare of individuals, especially children. In this chapter, weaknesses of the intensification project perceived by the author will also be posted. In addition, problems and difficulties encountered in the endeavor to meet the objectives of the study are described. This should assist future planning for undertakings of such kind.

2 Technological Change and Commercialization of Agricultural Production: Consequences for Human Nutrition

The elementary link between agriculture and nutrition in rural regions of economically poor countries is to maintain food availability through agricultural production and simultaneously to ensure food entitlements through incomes and food prices which allow access to sufficient food. This chapter will at first elaborate on this elementary link, particularly explaining the concept of food security in relation to livestock development.

It will then turn to the theory of agricultural growth, again focusing on livestock development strategies. Food availability based on mere expansion of agricultural production (crop area or herd enlargement) is no longer seen as a sustainable way to provide for the nutritional well-being of people in economically developing countries (Pinstrup-Andersen et al., 1997). Technical progress which usually takes place in tandem with commercialization is necessary to utilize existing capacities in labor, land, capital, and entrepreneurial talent to raise resource productivity and, incomes, particularly among smallholders (Ruthenberg, 1985). FAO and others emphasize the role of livestock development strategies as a driving force to food security and nutritional well-being (FAO/ILRI, 1995; Sansoucy, 1995; Winrock International 1992, Walshe et al., 1991).

In the third part of this chapter the relationship between agricultural change and child nutrition will finally be thoroughly discussed. At a more disaggregated level, the effects of agricultural change on the well-being of individuals are mediated through complex relationships at household and intra-household level. Decisions taken within the household in response to new technologies substantially effect the nutritional well-being of individuals. Additionally, exogenous factors such as education and community sanitation determine the nutrition of individuals (Pinstrup-Andersen et al., 1995).

Note on Terminology

In the following discussion terms are used to characterize the state of food and nutrition of individuals, households, regions, and nations for which consolidated universally applied definitions do not exist. For clarification how these terms serve the context of this study an explanation is given at the outset.

Malnutrition and Undernutrition

Two terms are used to describe a person whose nutritional constitution appears to be deficient. He or she can either be called *malnourished* or *undernourished*. Malnutrition and undernutrition are sometimes used interchangeably, but at other occasions rather distinct to describe two different nutritional constitutions. Michael C. (1997, 55)) defines *malnutrition* as ”any undesirable physical or disease condition related to nutrition”, it can be caused by ”eating too little, too much or an unbalanced diet that does not contain all nutrients necessary for good nutritional status”. In contrast to this, the term *undernutrition* is often used to emphasize a situation under which the diet is too short in food to sustain an adequate nutritional status. The term undernutrition is particularly used in connection with a rather one-sided perception of nutritional problems prevalent in economically poor countries. According to this perception, which dominated discussions throughout the 60ties and 70ties, nutritional problems related to food deficiencies were foremost viewed as a lack of protein and energy in the diet, called PEM (protein-energy-malnutrition). To bring public attention to a more comprehensive understanding of nutritional problems, which are to a large extend caused by deficits of certain micronutrients, such as iron, iodine, vitamin A, zinc or thiamin, another term, the so called ‘hidden hunger’, was created by nutritionists in the early 1990s and equated with the term *malnutrition* (Gibson, 1992; CIIFAD, 1996).

In this study the term *malnutrition* is preferred over *undernutrition*. It serves to describe an undesirable physical condition caused by eating too little or eating an unbalanced diet that does not contain all nutrients - macronutrients and micronutrients - necessary for good nutrition. The fact that malnutrition can also be caused by eating too much does certainly not matter in this particular context.

Food Security and Child Nutrition

Statements on the state of food or nutrition of households, regions, and nations are usually made by categorizing them as either *food secure* or *food insecure*. The food security concept addresses the risks of people not having access the required amounts of food. Its definition has changed over time and depends on the level of aggregation - household, region or nation - when applied. Generally food security refers to the situation of ”access by all people at all times to enough food for an active and healthy life” (WHO, 1993; World Bank, 1986).

Availability of food and *access to food* are the two essential determinants of food security. Comprehensive definitions of food security also include a time factor distinguishing chronic and transitory household food insecurity making stability of food supply an important element. Furthermore, food security and the nutritional well-being of individual household

members are determined by factors which are closely interrelated (v. Braun and Kennedy, 1994).

To examine how agricultural change potentially affects child nutrition, not only research that is directly concerned about agricultural change and its effects on child nutrition holds gainful insides. Inasmuch as food insecurity and malnutrition are closely intertwined, both spheres of research hold gainful insides into the subject and are therefore referred to in the discussion of the following chapter 2.1. Referring to this broad spectrum of literature also necessitates from the fact, that the awareness that nutritional problems exist even beyond acute food shortage is not as old as the approach to combat the problem of many people having too little to eat.

2.1 Agricultural Change and Human Nutrition

2.1.1 Linkages between Agricultural Change and Nutrition

”Agriculture and human nutrition are linked, but the links are much less direct then often assumed. Although obviously food must be produced to be consumed, changes in overall national food production are usually not a good proxy for changes in human nutrition in a particular country. Similarly, except for pure subsistence farmers, changes in food production on a particular farm may not result in changes of similar magnitudes in the nutritional status of the farm family” (Mebrahtu et al., 1995, 2).

Producing the quantities of food needed to satisfy the nutritional needs of all people is an essential prerequisite to prevent malnutrition. However, it is just part of the picture. Sufficient food production of a community or region (if necessary further supported by food imports) does not reach households who are too poor to acquire what they need for consumption. Rukuni and Eicher (1988) have called this basic relationship between availability of food and access to food ”the two sides of the food security equation”, which makes poverty a major determinant of food insecurity. They state that hunger and malnutrition are fundamentally related to poverty and that poor people foremost lack access to food. The awareness that hunger and malnutrition are not simply results of too little agricultural production lead Amartya Sen to advocate the so called ‘food entitlement’ of poor people (Sen, 1988,199). Increasing food production, storage, and trade can ensure food availability, but this will not automatically end hunger and malnutrition. Efforts are needed to enable resource-poor farmers and the landless to realize their access to food. This is basically possible when expanded food production either results in higher incomes for food-deficit households or when it lowers food prices for food deficit consumers, or both (Mebrahtu et al., 1995).

John W. Mellor (1984) provided theoretical background and empirical evidence that productivity enhancing agricultural technologies not only have the potential to increase total

food supplies, but also simultaneously increase incomes of smallholder farming households. This can generate effective demand even beyond the agricultural sector. Demand is created for a wide variety of labor intensive commodities such as dairy products, fruits, vegetables, and agricultural inputs. This inherits important potential for employment growth in rural areas. John W. Mellor reaffirms the role of technological change in agriculture as a major source of economic growth assigning it its place in the agricultural sector of countries with a high number of poor people living in rural areas (Mellor, 1984).

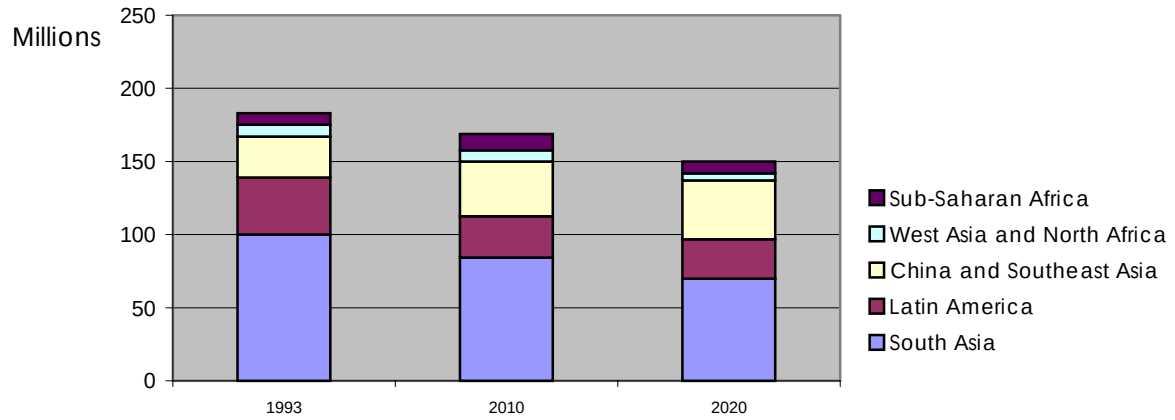
However, in order to combat hunger and malnutrition availability of and access to food resembling productivity increases and higher incomes of the poor are substantive, but not sufficient. Other factors such as the health and sanitation environment or education, particularly the education of mothers, play a decisive role in determining the nutritional outcomes of rural smallholder households (Behrman and Deolalikar, 1988). Furthermore, the correlation between increased food production and higher incomes and individual nutrition may still appear to be weak, because improved access to food may preferably be used to purchase nonfood items or additional food may not be distributed among household members in such a way that the needy receive the most (Mebrahtu et al., 1995). These are intra-household issues related to decision making and resource allocation, which will be discussed more detailed in chapter 2.3. This chapter continues to summarize the contributions of technological change to food security and human nutrition at a more aggregated level.

2.1.2 Recent Developments of the Food Security Equation of Sub Saharan Africa

Global food production has increased along with the growing human population over the past thirty years. Thomas Malthus' argument that the world's natural resources could not assure expansions in food supply that would match population growth was disproved in most regions of the world except for Sub-Saharan Africa (SSA), where since the 1960s the gap between food production increases and population growth is widening. Fortunately, recent developments suggest that "Malthus's shadow over SSA could finally be waning" (Pinstrup-Andersen et al., 1997, 21) provided that economic recovery and accelerated yield growth of African food crops due to productivity-increasing technology are persisting. However, worldwide more then 800 million people are estimated not to have access to enough food to meet their basic needs. Illustrated in Diagram 2.1.1, child malnutrition is expected to decline in all major developing regions except SSA, where the number of malnourished children could increase by 45 percent within the next 20 years to reach 40 million (Pinstrup-Andersen et al., 1997).

Diagram 2.1.1

Number of malnourished children 1993, 2010 and 2020

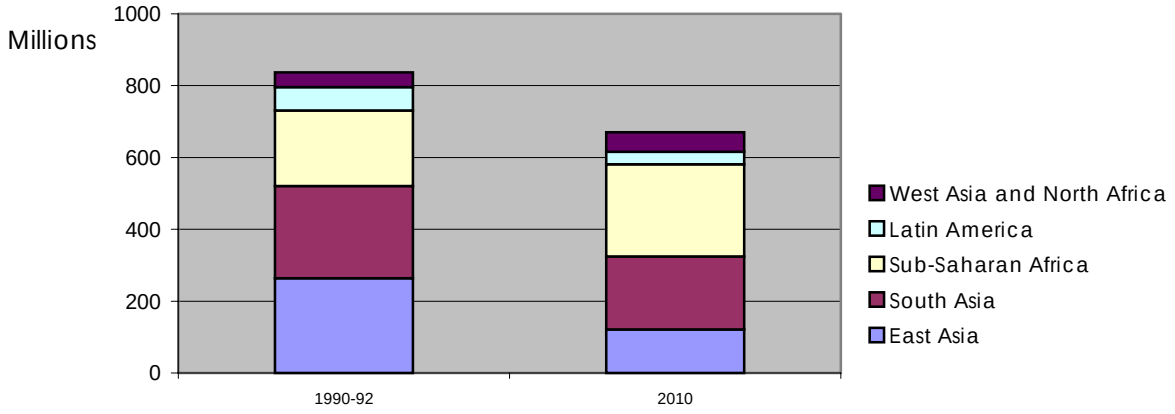


Source: IFPRI IMPACT simulations in: Pinstrup-Andersen et al., 1997.

The world population is projected to increase from 5,7 billion in 1995 to 7,8 billion in 2020 with the population of SSA almost doubling by 2020. Illustrated in Diagram 2.1.2, food insecurity could accelerate in SSA in the near future, unless initiatives are undertaken to further promote recent positive trends. Despite continuos increases in per capita food production, calorie availability is projected to only reach 2300 calories in SSA (Diagram 2.1.3). This is just barely above minimum requirements. Since food is not equally distributed to all, a large part of the region's population is likely to have access to less food than needed (Pinstrup-Andersen et al., 1997).

Diagram 2.1.2

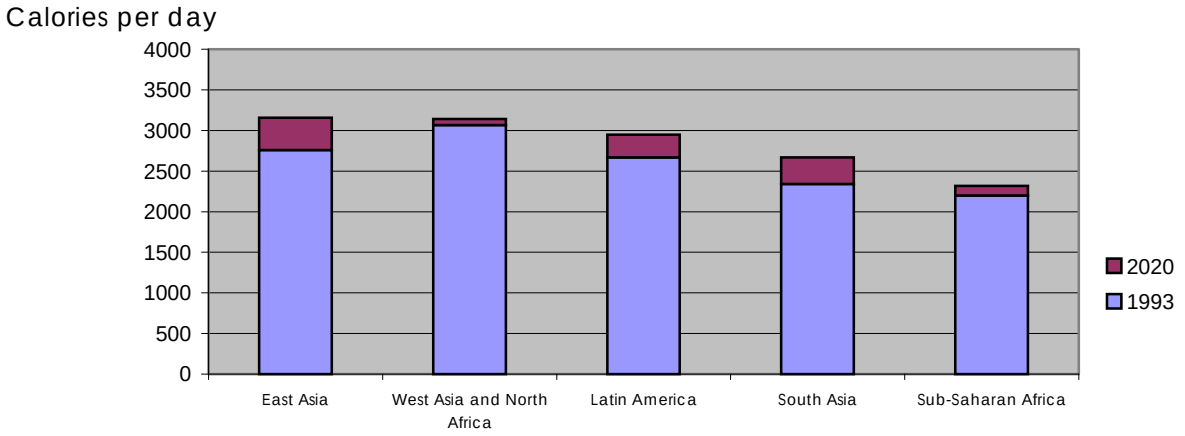
Number of food-insecure people 1990-92 and 2010



Source: IFPRI IMPACT simulations in: Pinstrup-Andersen et al., 1997

Diagram 2.1.3

Daily per capita calorie availability 1993 and 2020



Source: IFPRI IMPACT simulations in: Pinstrup-Andersen et al., 1997

Over the next quarter of a century the developing world's urban population is projected to double (Pinstrup-Andersen et al., 1997). Urbanization brings about increasing opportunity costs of women's time, changes in food preferences caused by changing lifestyles, and changes in relative prices associated with rural-urban migration. This leads to more diversified diets with shifts from basic staples to other cereals such as rice and wheat, which require less preparation. Likewise demand for milk and other livestock products increases (Pinstrup-Andersen et al., 1997). The number of all livestock categories in developing countries is rising. The value of production increases in livestock is even more rapidly rising then that of cereals. Still, the gap between growing demand and supply is widening and developing countries need to import increasing quantities of animal products, particularly dairy products to satisfy demand (FAO/ILRI, 1995).

2.1.3 Contribution of Livestock Development to Food Security and Human Nutrition

"Livestock production constitutes a very important component of the agricultural economy of developing countries, a contribution that goes beyond direct food production to include multipurpose uses, such as skins, fibre, fertilizer and fuel, as well as capital accumulation. Furthermore, livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability."(Sansoucy, 1995, 5)

At the national or regional level increased livestock production contributes to food security in a number of ways. Increased production will keep livestock product prices down which gives low income groups access to such food. Producers still gain in the face of lower prices, because livestock products are price elastic and income elastic. Consumption commodities

with such attributes maintain demand, total production, and farm revenue on elevated levels. Many resource-poor smallholders will gain direct access to more food of animal origin from own production. An advantage for the nation's budget is that increased domestic production reduces imports and hence helps to save foreign exchange, which can then be diverted to other investments and indirectly contribute to food security. Furthermore, livestock production and processing enterprises are labour intensive, thus increased production implies higher employment, which can secure income and food entitlement to the rural poor (FAO/ILRI, 1995).

Nevertheless, the role of livestock as a "driving force for food security" (Sansoucy, 1995, 5) has also been challenged, in particular for its potentially negative effects on the natural environment. The main issues of concern are competition for resources and environmental damage caused by rising numbers animals. Land and crops allocated to feed animals could alternatively be used for direct human consumption. A loss of soil fertility and desertification are caused by deforestation (creating space for grazing land) and overgrazing (keeping herd sizes beyond land carrying capacity). These negative effects stand in serious conflict with sustainable food production increases, but they are not necessarily attributes of livestock development per se. Research has been oriented towards the development of strategies which should help to eliminate negative effects of accelerated livestock production. Sustainable livestock development will have to consider the availability and efficient use of natural resources on the base of resource management plans that complement the wider economic, ecological, and sociological objectives. Land-use systems must be understood in their full complexities, including social, cultural, political, and institutional elements that affect the management of natural resources. Finally, technical and institutional support and government commitment are asked for (FAO/ILRI, 1995).

2.1.3.1 Livestock Ownership Contributing to Smallholder Food-security

At the farm level, direct and indirect benefits from livestock ownership have potential to contribute to four components of household food security - availability, access, utilization, and stability. What this means in particular will be explained more detailed in the following section.

Livestock Development Providing Access to Food

For many smallholders animal products are foremost a source of disposable income. They prefer to exchange the comparably expensive commodities such as meat, milk or eggs for larger quantities of cheaper foods, mostly local staples or vegetables (Alderman, 1987; Bouis and Haddad, 1990). Depending on ecological zone and livestock system the actual

role that different livestock species play, their function and importance as an income generator in the smallholder economy varies (Jahnke, 1992). The dynamics behind livestock as a generator of cash income may be regarded similar to that of cash crops in other farming systems (Alderman, 1987). Disposable income can be used to provide for family needs like medicine or school fees. Furthermore, it may determine whether a farmer is able to provide the liquid assets needed to buy agricultural inputs, such as fertilizer or seeds. This has been observed for the Ethiopian highlands (Gryseels and Whalen, 1984), where crops are more often a subsistence enterprise, whereas livestock accounts for a high share of total cash income from farm sales. Under other circumstances food-self sufficiency in crop production might not be aimed at, rather food crops are purchased with cash income obtained from livestock sales. This is for example the case in pastoral systems.

Livestock Development Providing Economic Stability

At the household level livestock ownership provides increased economic stability, a vital part of food security. In this regard, small livestock is mainly acting as a cash buffer, large animals as a capital reserve or a deterrent against inflation. In mixed farming systems, livestock also functions as an insurance against the risks associated with crop production, such as seasonal crop failure or other natural calamities. Livestock represents liquid assets which can be realized at any time, adding stability to the production system (Jahnke, 1982). Likewise frequent and regular income obtained from the sale of milk or eggs adds to stability and has been observed as an important determinant of household food security (v. Braun and Kennedy, 1994).

Livestock Development Enhancing Food Availability

Smallholder livestock development makes more livestock products available directly for consumption, provided that small scale farmers can afford to forgo the cash income from the alternative option of marketing the produce. Moreover, farmers benefit from increased intensification and integration of livestock and crop production. While crop residues and by-products can be made available as animal feeds, animals supply manure which helps to maintain soil fertility. They also supply draught power for plowing and other farming activities. Alternatively dung can be used as fuel for cooking. Occasionally found, though more prominent in South East Asia, biogas is produced from manure. In this case it serves as both, energy and fertilizer (Sansoucy, 1995).

More than half of the cultivated area of the economically developing countries is farmed using draught animals. In mixed crop-livestock systems, where animals, mostly oxen or buffaloes, are used for plowing, crop yields are influenced by availability or accessibility of draught animals. In these environments, cereal crop production positively correlates with

draught animal ownership (Gryseels, 1988). Likewise, manure is an important contributor to crop production when it is used to increase soil fertility. In addition to the recycling of essential plant nutrients, manure provides important organic matter to the soil maintaining its structure, water retention and drainage capacity. Furthermore, soil fertility is sustained through nitrogen fixation by cultivation of legume fodder plants and trees. In some livestock systems animals are also used for weed control. All these factors make livestock an important determinant of food availability and thus food security (FAO/ILRI, 1995).

Livestock Development and Utilization of Food

Livestock, and especially dairy, can make unique contributions to the nutrition of smallholder household members, particularly the micronutrient and health status. Contrary to the developed world, where many people eat too much animal products, most people throughout Sub-Saharan Africa eat too little animal products for good nutrition. Under these circumstances, increased milk consumption has a significant positive effect on the nutritional status of household members, especially children (Murphy, 1996).

Besides containing important nutrients, especially carbohydrates, protein, and calcium, dairy products contain micronutrients in bioavailable form, that means they can be easily utilized by the human body. These nutrients are foremost vitamin A (retinal), the B-complexes and zinc, essential for growth and proper physical and mental development. Studies undertaken in Kenya have shown that children deprived of vitamin B_{12}, which comes only from animal products, suffer impaired learning abilities. Children, who received comparatively more milk and dairy products on the other hand, showed better cognitive results and were better nourished (Murphy, 1996).

2.2 Smallholder Benefits from Livestock Intensification

2.2.1 The Case of Dairy Intensification

Dairy intensification is one of numerous strategies to develop animal agriculture in Sub-Saharan Africa (Winrock International, 1992). This is particularly true, where integrated crop-livestock systems already exist, which is the case in the Ethiopian Highlands. Here livestock is of crucial importance for farmers who benefit from a high level of crop-livestock integration (Gryseels and Whalen, 1984). McIntire et al. (1992) view this as one of the later stages in a process of increasing crop-livestock integration, which, if accompanied by sustained population growth ultimately leads to more and more specialized farming enterprises. Population pressure creates scarcity in land, thus increasing the opportunity cost of land relative to labor, which results in more intensive use of land. Absent markets or physical infrastructure, a hindrance for farmers to obtain inputs, promote closer integration of crop

and livestock activities. They create the incentive to provide inputs produced directly on farm. A final stage of livestock development is reached, when, in the presence of markets and technologies, purchased inputs replace crop-livestock integration and, at last, completely specialized enterprises are formed. This development is observed for urban areas, where transport costs of inputs and products are lower than in rural areas. Specialized animal production such as dairying, small ruminant, or poultry production develop. The adoption of technologies for intensified dairy production in the Addis Ababa milk shed is regarded as one of these intensive commercial systems developing around major cities in economically developing countries representing what is usually called periurban livestock systems (Ehui et al., 1995).

At the present stage of livestock development, a set of technologies designed to facilitate dairy intensification by periurban smallholders in the Ethiopian Highlands promotes further integration of crop-livestock production (Gryseels, 1988). Occasionally farmers have been shown to rely on purchased inputs benefiting from industrial by-products available in Addis Ababa (Hurrissa et al., 1993). A 'typical' smallholder household in the peri-urban region of the Ethiopian Highlands, deciding to adopt technologies for intensified dairy production needs to invest capital into upgraded dairy animals. A stable, suitable for more vulnerable zero- or semi-zero grazing animals, and a parcel of land to produce fodder on farm have to be supplied. The household will profit from higher milk yield, but to maintain this benefit increased labor input is needed. Stable cleaning or grazing, milking, dairy processing, and marketing of upgraded animals demand more hours of labor than keeping indigenous animals. The increased time allocated to the animals might not be increased proportionately for all household members (MoA/FINNIDA, 1991). The workload of men or women might increase more. The new dairy enterprise also demands new management skills. As exemplified above by the case of the 'typical' smallholder, a more commercialized farm activity, facilitated by technological change, has divers household and intra-household effects. The implications of such changes on child nutrition are determined by decisions made by the household in response to the adoption of the new technology.

2.2.2 Benefits from Technological Change and Commercialization

The adoption of a set of technology, in this case a technical innovation to intensify dairy production, enhances the efficiency in production, which in economic terms provokes an upward shift of the existing production function. Technical innovation reduces unit costs of production by increasing productivity of one or more resources (Ruthenberg, 1995). Dairy intensification represents 'land saving' technological change in the sense that it is primarily increasing the productivity of the land resource. Production increases of the most limiting

resources are regarded to promise relatively higher profits to farmers making the adoption more attractive. ”Practically all new technology is embodied in new forms of capital, such as seeds, chemicals, machinery, equipment, or structures. Hence innovation involves investment” (Ruthenberg, 1995 , 28). The rate of return on the investment is then the gain in income the farmer benefits from.

Smallholders will benefit from increased milk yields directly, when they themselves consume the produce at the household. This would imply that the opportunity costs of milk and dairy products are perceived to be rather low. Farmers are poor and it is more likely the case that milk and dairy products appear like luxury goods to the smallholder, which have very favorable terms of trade in the regional market. This makes it more feasible to sell the produce and use the cash income to purchase larger quantities of cheaper food commodities (Alderman, 1987). This indirect effect of dairy production on food consumption and nutrition is more prominent (v. Braun and Binswanger, 1991). Whether a household decides to use the cash income to purchase food in amount and quality required to satisfy the needs of all household members is a crucial question and will be further discussed in section 2.3.3. In addition to sale of production output, increased commercialization does also take place at the input side. In the case of intensified dairy production farmers need to purchase concentrates, fodder, building material for the stable, and prophylactic and curative animal health services upon which the higher productivity of the animals relies.

Farmers benefit from higher total factor productivity - the technological change - and gains from specialization and trade - increased commercialization (v. Braun, 1995). Ideally, technological change and commercialization move jointly in a reinforcing way, commercialization facilitating the generation and diffusion of new production technology and technological innovation reinforcing the gains from specialization (Binswanger and v. Braun, 1991). Nevertheless, one important aspect of the stronger involvement in the market economy is that smallholders are more susceptible to the risks of unstable prices and market failure. This can have negative consequences for food security and nutrition. As often observed, a smallholder strategy to encounter this insecurity is to maintain a certain level of subsistence food production, in spite of higher returns to land and labor from the commercialized farm enterprises. These are not simply foregone gains from specialization and trade, but an insurance against the risks of unreliable markets (Binswanger and v. Braun, 1991). ”The higher the transaction costs in food markets and the closer the households are to food insecurity, the stronger the preferences for high shares of subsistence food production” (v. Braun, 1995, 200).

2.2.3 Impact of Technological Change and Commercialization on Child Nutrition: The Evidence

While technological change in agriculture is understood to be a necessary condition for accelerated economic growth and food production in Sub-Saharan countries (Mellor , 1984), the immediate impact of technological change on smallholder food security and child nutrition, especially when it involves increased market involvement through cash cropping schemes or dairy intensification, remains a controversial issue. There is wide diversity in the types of effects observed. Studies exist stating that health and nutritional well-being of children decline as households move from subsistence oriented food production to the production of cash crops for sale in domestic or export markets. Other studies have found neutral or positive association between cash crop production and the nutrition of children[2]. J. v. Braun states that the argumentation which is found in a large body of literature, that commercialization of agriculture mainly has negative effects on the well-fare of the poor, "probably emerged from a mix of historical, real, ideological, and methodological factors:

1. adverse effects that resulted from coerced cash crop production that constrained the capacity of smallholders to cope with risks under some colonial production schemes;
2. noted exploitation of smallholders under monopsonistic conditions of projects;
3. general suspicion that commercialization leads to adverse "capitalist" production and marketing relationships (whereas subsistence agriculture was idealized as providing food sufficiency); and
4. non-comprehensive studies and anecdotal evidence" (v. Braun and Kennedy, 1994, 4).

Substantial part of research and project assessments undertaken in the past is now perceived to be based on a rather simplistic perception of the relationships between agricultural change and nutrition. Conceptually flawed, such studies, which are mostly comparative in nature, often disregard potentially compounding factors by simply comparing nutrition with and without cash crops. Therefore it remains unclear whether the identified effects are caused by increased market integration of smallholder agricultural production per se or some confounding factors (Mebrahtu et al., 1995). But above all, from the range in types of effects observed it cannot be concluded that technological change and commercialization are inherently disadvantageous for child nutrition (v. Braun and Binswanger, 1991).

Recent studies, conducted under more carefully conceptualized study designs, come to the conviction that increased commercialization of smallholder agricultural production has no negative impact on the nutritional status of children. Still, while the prevalence of malnutrition

[2] This statement is based on literature reviews by Kennedy et al., 1992 and Mebrahtu et al., 1995.

among children of households participating in cash crop production schemes was found to be lower, the difference between children of cash crop producers and non-producers was not always statistically significant. Table 2.2.1 presents the growth performance of children from cash crop producers and non-producers at different study sites. As an indicator of malnutrition the percentage of children stunted in growth is documented.

Table 2.2.1 Prevalence of stunting among preschool children of cash crop producers and non-producers

	Percentage of preschoolers below 90 percent height/age	
Country	cash crop producers	non-producers
The Gambia	9,4	17,3
Guatemala	66,7	72,8
Kenya	24,3	25,3
Malawi	55,2	52,7
Philippines	32,2	36,3
Rwanda	18,6	24,0

Source: Kennedy, Bouis and v. Braun, 1992 (modified).

Although at all study sites substantial increases in income due to participation in cash crop schemes took place, associated improvements in child nutrition expressed in the relevant elasticities were rather low. Results suggest that even where linkages between income and child nutrition are statistically significant the magnitude of the income effect at the level of the child is often small. For the various settings a 10 percent increase in income only results in 1,1 - 2,5 percent increases in the nutritional status of children. These findings suggest that major income increases by smallholder producers would be required to archive the necessary improvements in child nutrition (Kennedy, Bouis and v. Braun, 1992). An exception to this modest effect of incremental income on the situation of child nutrition was found in the case of very poor households in a commercialization scheme in Rwanda where people suffered from acute food constraints. Household food availability was noticeable improved and the problem of hunger was overcome. However, the problem of child malnutrition could not be solved (v. Braun, de Haen and Blanken, 1991).

In summary, the relationship between the effect of agricultural change and income on food consumption and child nutrition appears rather weak. The reason for this is doubtless the plenitude of underlying factors causing child malnutrition and “their complex interrelationships - a web of biological, social, and economic factors and relationships, which are location-specific and often poorly understood for a particular population group, location,

and time period" (Pinstrup-Andersen et al., 1995, 2). However, it is important to understand these relationships, which can only be tackled at the level of individual households. If unrecognized or ignored, simplistic policy recommendations are likely to follow and potential benefits are forgone (Kennedy and Bouis, 1993).

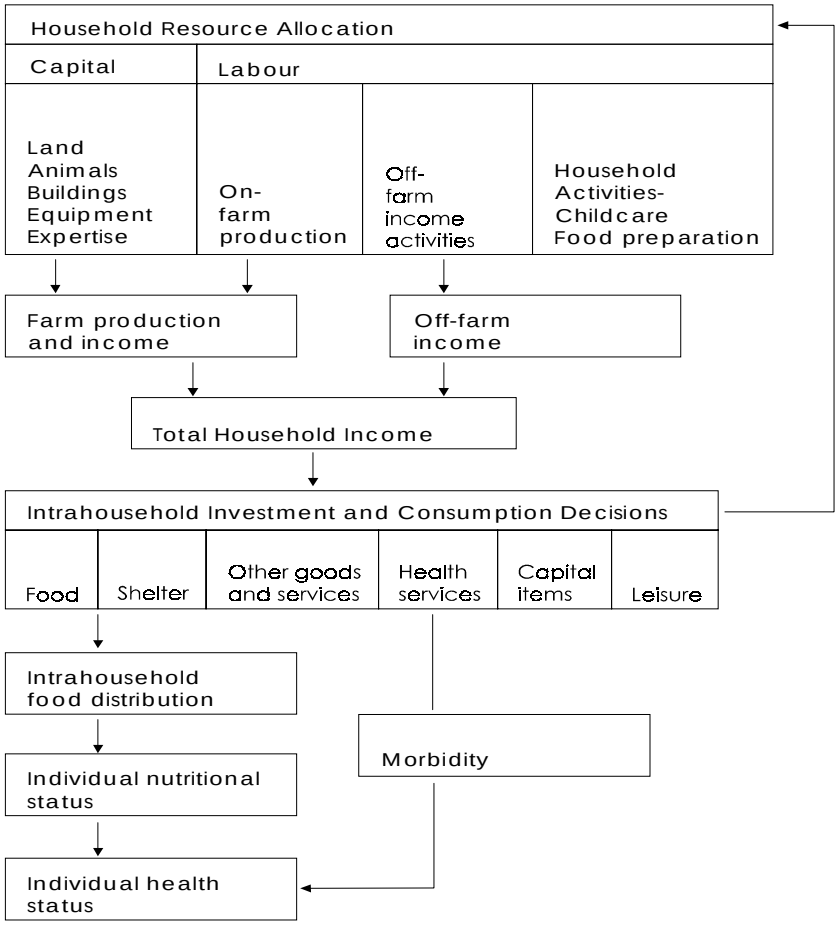
2.3 Dynamics behind the Agricultural Change - Child Nutrition - Relationship: Intra-household Resource Allocation and Distribution of Benefits

2.3.1 A Framework for Linkages between Agricultural Change and Child Nutrition

Nutritional status manifests itself at the level of the individual, but it is an outcome of a combination of complex social and economic processes at household, community, national, and even international level. Considering the external situation, a household has to decide how to allocate available resources so as to ensure food security and adequate nutrition for its members. Based on the economic theory of the farm household model[3], including the aspects of intrahousehold decision making, the framework illustrated in Diagram 2.3.1 conceptualizes pathways through which agricultural change can potentially influence the nutritional status of children. The framework provides an overview of the major links between agricultural change and human nutrition, as perceived by Kennedy and Bouis (1993) with slight modifications by the author:

[3] Singh, Squire and Strauss, Agricultural Household Models, 1986, further explained in section 4.1.1.

Diagram 2.3.1 Framework for linkages between agricultural change and human nutrition



Source: Kennedy and Bouis, 1993.

Generally, the most direct link between technological change in smallholder agriculture and improvements in child nutrition is increased household food availability from own production, which in economic terms is part of the incremental income (in-kind income) from cash crop production. It is important to notice that these changes in the quantity of food produced will affect nutrition primarily through changes in incomes (and prices), which in turn should not alter household food consumption preferences[4]. Dairy development schemes are believed to directly contribute to improving nutrition of dairy producers by making more milk available for home consumption. However, the effects on consumption and nutrition were observed to be of a more indirect nature. Dairy smallholders sell expensive calories (milk) and increase net purchases of cheap calories, thereby improving food consumption (Alderman, 1987).

Nevertheless, the most prominent or 'primary' link remains the income - food consumption - link, where increased income facilitates increased food expenditure. However, this link is

[4] In recent studies an effect over and beyond that working through incomes and prices has been observed. Whether this is due to perceived or real differences in transaction costs between produced and purchased quantities could not be answered yet (Alderman, 1990).

less straightforward than often anticipated. Household and intra-household decision making processes, influenced by the nature of the new technology, economic considerations, social status, customs, and believes, play a crucial part in the relationship of increased income and improvements in nutrition. In this regard the primary link depends upon three main spheres of household and intrahousehold decision making, which are identified in v. Braun and Kennedy (1994):

1. One refers to the allocation of income for food and non-food expenditures (and labor allocation).
2. At the next level decision making relates to how the available food budget is actually spent. It is decided upon which types and quantities of food are purchased.
3. The third decision making level concerns how available food and other commodities which affect nutrition are distributed among household members.

2.3.2 Immediate Determinants of Child Nutrition

Depicted at the bottom of Diagram 2.3.1 are two factors known to immediately influence the nutritional status of individuals. One factor is food, the other factor is health, but both factors are, moreover, also intimately intertwined. Inadequate dietary intake *and/or* disease are the immediate causes or determinants of malnutrition. Inadequacy in diet may include insufficient intake in total energy, proteins, vitamins or minerals. Moreover, inadequate dietary intake may increase the susceptibility to and severity of infection; conversely, many infectious diseases reduce dietary intake and nutrient utilization through loss of appetite and reduced absorption. A case in point is the increased susceptibility and severity of infections under vitamin A deficiency, a hazard more than 200 million children, mainly living in economically developing countries, suffer from. It is well established that vitamin A deficiency significantly increases morbidity as well as mortality. Even a mild level of deficiency increases the chance of dying from a common infection by 20 percent (Latham, 1997).

Evidence from five study sites suggests that the unaffected poor health situation is responsible for the very modest improvements in child nutrition. While increased income leads to more food available at the households, the problem of child malnutrition remains because of the persistent high morbidity among children (Kennedy and Cogill, 1987). Likewise a poor community health and sanitation environment overshadows potential positive effects on nutrition, when, as in the case of The Gambia, no adequate drinking water is available (v. Braun, Puetz and Webb, 1989). To the contrary, a study in Guatemala emphasizes a noticeable and comparatively strong positive impact on child nutrition, where a commercialization scheme was accompanied by investment of project returns into

community development and social health infrastructure (v. Braun, Hotchkiss and Immink, 1989).

UNICEF (Jonsson, 1995) demands that attention is also focused on another, rather immediate factor of paramount importance for child nutrition. They state that in order to satisfy the nutrient needs of children in a particular household, available resources have to be organized in a manner fulfilling three basic conditions:

1. Adequate access to *food;*
2. Adequate access to preventive and basic *health* services together with a *healthy environment*;
3. Adequate *care* of children (and women).

The first two conditions - the provision of food, sufficient in quantity and quality to fulfill all nutritional requirements of all household members throughout the year (food security) and access to health services, together with a healthy environment, e.g. including for example immunization, oral rehydration therapy, de-worming, health education, access to water, safe excreta disposal, etc. - have already been discussed. The third condition - adequate *care* of children and women - has only recently been fully recognized as having an important bearing for the nutritional status of children. 'Care' refers to caregiving behaviour such as breastfeeding and complementary feeding practices, food and personal hygiene, diagnosing illnesses, and a number of cognitive capabilities as well as providing emotional support. Important causes of inadequate child care include poor health of the mother; lack of education and wrong beliefs of caregivers; inadequate social support from the community, family, and husband; excessive workload of the mother, to name but a few (Jonsson, 1995). Particularly the education of mothers has been found as a crucial element and basic factor influencing household behaviour in regard to child nutrition determinants (Behrman, 1995).

2.3.3 Factors determining Resource Allocation to Improve Child Nutrition

A number of factors can potentially determine household resource allocation decisions and impact on child nutrition in either positive or negative ways. Here four prominent and frequently investigated factors are described; the labour burden of women and possible consequences for child nutrition; the effects of changes in income control; the issue of preferences for individual household members and the related distribution of food or other resources; and finally how the education of women can determine child nutrition.

A basic element of child care and the ”strongest possible foundation for nutrition” (Armstrong, 1995, 299) is breastfeeding. Breastfeeding practices are believed to be strongly affected by the value of women’s time. Agricultural change and commercialization can increase the opportunity cost of women’s time spent on home production and child rearing. Particularly increased involvement in marketing activities is believed to cause women to curtail breastfeeding, as well as other care activities that are believed to be critical in preventing child malnutrition. However, empirical evidence does not reveal a clear association between women’s market involvement and infant feeding practices and child nutrition (Leslie, 1988). Generally the prevalence of breastfeeding was not found to be related to women’s work status. Nevertheless, it remains an important factor for the nutritional status of children.

Summarizing results from five study sites, Kennedy et al. (1992) conclude, that, while there are variations across settings, women’s direct control over income from the cash crops was much less than men’s and was often disproportional to their labour input. This is a very strong indication for welfare losses, because women are known to have a higher preference to provide for household food consumption than men (Quisumbing, 1996). However, food expenditures, as well as other expenditures with a high welfare content, still increased in absolute terms as incomes controlled by men rose. This has, as mentioned above, a positive although not large impact on child nutrition. But not only who controls income affects the expenditure pattern. It has also been observed that income received in lump sum is differently spend from income received in small but regular amount. While the latter is rather used to purchase food, the former is used for investments, for example in better housing or school fees (Kennedy and Cogill, 1987).

Another aspect which should not be overlooked is the preference for particular household members in the distribution of food. Household food consumption has often proven to be a poor proxy for an individual’s caloric intake (Bouis et al., 1992). In some cultures boys get preferential treatment in the allocation of food and other resources, but this is mainly found in South Asia and little evidence is found for this gender bias to occur in Africa (IFPRI, 1992).

Another factor, thoroughly described in Behrman (1995), which not only knowingly affects child nutrition, but is also closely associated with the process of technology adoption per se, is education. The effect has been observed for formal as well as informal education of mothers. Better educated mothers often exhibit behaviors that are more child-centered, which leads to better feeding practices and more resources allocated to the children. The education effect of women is established through better information gathering abilities and improved bargaining positions towards the husband or other household members.

3 Smallholder Dairy Intensification in the Ethiopian Highlands

This chapter begins with an outline of the existing farming environment, its bio-physical potential as well as the socio-political situation, that shape the prevailing production system. The specific situation in the Ethiopian Highlands is described, emphasizing the prevailing rural welfare and nutrition situation. It then turns to the capital and its dairy market. Addis Ababa heavily depends on smallholder dairy production in the peri-urban region around the city. The supply and demand parameters are presented and the general situation for increased market involvement of smallholders illustrated. Finally, the traditional smallholder mixed crop-livestock system prevailing in the study area is scrutinized and technological and institutional changes due to intensification and commercialization discussed.

3.1 Farming Environment in the Ethiopian Highlands

3.1.1 Bio-physical Farming Potential

Ethiopia is a country that exhibits a great geographical diversity with its high and rugged mountains, flat-topped plateaus, deep gorges, incised river valleys, and rolling plains, altogether covering a total area of some 1 130 000 square kilometers. It shares its northern boundary with Eritrea, its western boundary with Sudan, its southern boundary with Kenya, and its eastern boundary with Somalia and the Republic of Djibouti, leaving Ethiopia with no direct access to the sea. Ethiopia's distinctive geographic characteristic is the central highland mass being surrounded by lowlands. The main relief feature of the country is the high central plateau from which mountain peaks rise to over 4000 meters above sea level, whereas the Dallol Depression reaches 100 meters below sea level. Desert areas occupy about one-third of the total area surrounding the highlands. The Ethiopian Rift Valley bisects the surface of the plateau, this being part of the Great Rift Valley system that extends from Syria to Mozambique (UNDP, 1994).

Its proximity to the equator together with the country's great altitudinal range creates climates varying from continental cold to temperate, sub-tropical, and tropical. This explains its great variation in natural vegetation. Savanna and grassland dominate the highland's vegetation, the whole western part of the country is covered by montane and temperate grasslands or montane tropical vegetation, parts in the south are still covered by tropical forest. Deciduous forest is found in some parts in the west of Ethiopia. In Ethiopia's east and south east steppe and desert, tropical bush and thorn dominate, in the lowlands tropical thickets (FAO, 1986a).

Nohlen (1982) commends the high farming potential of the Ethiopian Highlands, the highlands being one of the world's eight independent centers of the cultivation of crops. Still today one finds the world's largest number of wheat and barley varieties in Ethiopia's highlands. Fertile soils and rich rainfalls theoretically support two to four harvests per year, which would make Ethiopia the granary of whole East Africa and the Near East. About 80 to 90 percent of the total human population of Ethiopia live in the highlands and about 70 percent of the country's livestock population is located here.

Climate

Ethiopia's climate is characterized by three seasons: The *belg* season (small rains) from February to May, the *keremt* season with the *meher* rains from June to September (big rains), and the *bega* season (dry period) from October to January. Under normal conditions, with two rainy seasons, many regions are presently able to produce two harvests a year. There are, however, considerable variations. In the highlands about 30 percent of the bimodal rainfall is due to the *belg* (February to May) and 70 percent due to *meher* (June to September). Variability in occurrence of rainfall is high for the *belg,* but low for the *meher* period. Average annual rainfall is ranging between 800 mm and 2000 mm (FAO, 1986a).

Soils of the Tropical Highlands

The highland soils' basement complex is of volcanic origin. Predominantly Eutric Nitrosols, Andosols, and Vertisols are found in the Ethiopian Highlands (FAO, 1986a). Vertisols dominate plateaus and depressions. They are dark clay soils, also called deep cracking clays, because of their prominent deep clefts appearing in the dry season. Regarding physiological and chemical properties, presence of organic matter, nutrient content, and water carrying capacity, these soils exhibit comparably favorable farming conditions. Inconveniences arise for farmers, because clay soils are hard when dry and sticky when wet, therefore adequate power is needed in order to till them and tilling has to take place within a short period of suitable time. This is likely to create tillage problems. Likewise water logging in depressions, P-fixation and soil erosion on slopes are problems encountered. Drainage and erosion control measures are necessary to improve accessibility and crop growth, still overall farming potential of dark clay soils is considered good (Scheffer and Schachtschnabel, 1992).

Farming Potential

In terms of farming potential it is useful to classify the Ethiopian Highlands into three agro-ecological zones (Gryseels, 1988). A distinction is commonly made between the *high potential cereal-livestock zone*, the *low potential cereal-livestock zone*, and the *high potential perennial-livestock zone*. Table 3.1.1 illustrates the main characteristics of the three major agro-ecological zones further described below.

Table 3.1.1 Characteristics of the major agro-ecological zones in the Ethiopian Highlands

	High potential cereal-livestock	Low potential cereal-livestock	High potential perennial-livestock
Area (km²)	149,900	134,000	139,500
Population density (persons/km²)	73	72	74
Livestock density (TLU/km²)	55	30	27
Proportion of total highlands' livestock population (%)	41	26	33
Growing period (days)	150 to 240	90 to 150	above 240
Agricultural output	cereals, pulses, livestock	cereals, pulses, livestock	coffee, tubers, enset, livestock
Altitude (meters a.s.l.)	1500 to 3000	above 3000	1500 to 3000

Source: Gryseels, 1988, 44 (modified)

The *high potential cereal-livestock production zone* has the largest livestock population, about one half of all livestock of the highlands is situated here at an altitude between 1500 and 3000 meters a.s.l.. About 50 percent of all cereal production is located here. Main crops grown are barley, wheat, and pulses. Large segments of the land in this region are left fallow or are used as pasture land for grazing (Gryseels, 1988).

The *high potential perennial-livestock production zone* is the most important region for crop production. About 70 percent of all cereal production is located there at an altitude between 1500 and 3000 meters a.s.l.. Main crops grown are teff, wheat, coffee, maize, fieldpeas, and horsebeans. Only very few slopes are too steep to permit crop cultivation. Land exclusively used as pasture is restricted to depressions with problems of waterlogging. Cattle is used for draught purposes and meat and dairy. Small livestock is mainly a capital reserve (Gryseels, 1988).

The *low potential cereal-livestock production zone* covers the region above 3000 meters a.s.l. Main crops grown are barley, wheat, and pulses. Periods of frost restrict the length of the crop growing period to 90-150 days. Farmers rely on large sheep herds. Cattle is predominately kept for draught purposes. Because of its low farming potential, partly due to waterlogging and steep slopes, vast segments of the land are allocated as pasture land for grazing (Gryseels, 1988).

3.1.2 Socio-political context

Analogous its geographical diversity Ethiopia is a multilingual and multiethnic country. About 40 percent of the population are followers of the Ethiopian Orthodox Church and about 40 percent are Moslems. Some local religions are found in the south west of the country. North of Lake Tana used to live about 50 000 Falach (Beta Israel), before many of them emigrated to settle in Israel (GTZ, 1997). Nevertheless, all Ethiopians share a history marked by years of turmoil resulting from internal strife, claims of territorial sovereignty by Eritrea, disputes over land with Somalia, repeated drought and economic crises. It appears appropriate to view Ethiopia's current state of affairs and economic situation within the context of these recent historic events and political changes, because many of these developments and changes directly or indirectly effect the lives and farming conditions of smallholders throughout the country, including the study area.

Ethiopia was ruled by successive monarchies until 1974 when the last monarch Emperor Haile Selassie was disposed in a coup. The rule of Emperor Haile Selassie was characterized by a continuously growing agrarian crisis with a large part of the rural population suffering from inequitable distribution of land and severe drought and famine between 1972 and 1974. The coup leaders of 1974, led by Mengitu Haile Mariam, formed a government and eventually embarked on a course of socialist development. The government, termed the Dergue, ruled from 1974 to 1991 and prosecuted a war for 17 years until it was forced out of power. Popular support for the Dergue regime decreased as a result of economic and political disasters, including another catastrophic drought in 1984/85, unpopular resettlement programs known as villagisation and a third famine in 1989/90. After 30 years of protracted armed conflicted, the war ended with the establishment of the Transitory Government of Ethiopia in 1991 (UNDP, 1994). In 1995 the first free general elections took place.

Since 1995 the overly centralized structure of the Dergue regime has been replaced by a decentralized system consisting of 10 ethnic and linguistic regions and 647 Woredas (basic units of a region) (UNDP, 1994). Each level of administration exercises its own political power and legal personality. An on-going process of privatization has transformed ownership and control over previously state owned assets to the private sector to come to better efficiency of resource allocation and utilization by the reduction of state participation in the economy. Contrasting the former military regime, this is part of an new overall policy of liberalization and freeing of market forces. Critically observed and called into question by many observers is the land tenure policy of the present Ethiopian government that does not allow any private land ownership, because it is believed to restrain necessary investments (GTZ, 1997).

The total population of Ethiopia is estimated to be around 53 million people growing at over three percent annually. The dependency ratio of the population with 48,2 percent below the age of 15 and 4,7 percent over 65 is considered high. The population density for the whole country is only 45 persons per square kilometer. The pattern of population distribution is, however, uneven. In the lowlands there are living less then 30 people per square kilometer whereas in the central highlands 90-120 people are living per square kilometer (UNICEF, 1993).

3.1.3 The National Economy and People's Welfare

3.1.3.1 The Economic Situation

The current economic situation is probably best summarized in a statement made by UNICEF (1993, 11) expressing: "The Ethiopian economy suffers from a lack of technological know-how, absence of developed infrastructure facilities, a small industrial base, shortages of skilled manpower, rapid population growth, soil erosion, recurrent drought and famine, a shortage of foreign exchange, and the misguided policies of the former government. The agricultural sector, which is the mainstay of most Ethiopians, has suffered the most."

The structure of the economy, depicted in Table 3.1.2, is characterized by the importance of the agricultural sector and far smaller shares of the GDP (gross domestic product) derived from industrial production, manufacturing or services. The total GDP in $US has decreased from 1980 to 1994, but this number should be taken with caution, because of the devaluation of the birr in 1992 (from 2,05 birr/$ to approximately 6 birr/$) and the liberation of Eritrea from Ethiopia in 1991 (World Bank, 1996).

Table 3.1.2 Production structure of the economy

	Agriculture		Industry		Manufacturing		Services	
	1980	1994	1980	1994	1980	1994	1980	1994
Distribution of GDP	56%	57%	12%	10%	6%	3%	31%	32%
Total GDP (million $US):		1980		1994				
		5,179		4,688				

Source: World Development Report 1996.

There has been continues economic growth since the economic policy reforms by the transitional government in 1991. In 1992/93 the real growth was 7,6 percent, largely due to a 4,9 percent recovery in agricultural output and stronger than expected industrial growth of 12 percent. Still, as depicted in Table 3.1.3, the estimated GDP per capita for the year 1993 of 110 US$ is very low compared to other Sub-Saharan African countries (FAO, 1996b; World Bank, 1996).

Table 3.1.3 Per capita GDP in $ US

	Ethiopia	Tanzania	Kenya	Low-income economies
GDP per capita (1994 in $US)	110	140	250	360

Source: World Development Report 1996

65 percent of the rural population and 60 percent of the urban population are believed to be living below an absolute poverty level. Another alternative indicator of the national economy is suggested by Sir R. St. Barbe Bakers (1991), according to which the economic stability of states is reflected in their land area covered by forest. In this regard Ethiopia's poverty in fact is accentuated by severely decimated forest coverage from 40 percent in 1920 to below 3 percent in 1995 (FAO, 1996a).

3.1.3.2 The State of Affairs of Agriculture

49,6 million of the total population of about 53 million Ethiopians, can be located in agriculture. And of about 25,5 million economical active men and women, 21,7 million work in agriculture, which equivalents to 85,3 percent of the country's labor force working in the agricultural sector. Urban unemployment is high, although this is made up for, to some extent, by a parallel economy which has expanded under the new government (UNDP, 1994). In the period between 1991 and 1996 noticeable production increases took place in agriculture. In this period increases in crop production amount to 40 percent, 66 percent of

which cereals account for. Livestock production increased by 3 percent. The total agricultural sector expanded by 25 percent production increases (FAO, 1996b).

Agricultural production contributes an essential amount to the country's export earnings. In fact, there are no substantial export earnings apart from crude oil sales, which are not of agricultural origin (bfai, 1995). Table 3.1.4. lists the most important export goods and also illustrates that there have been substantial increases in export earnings from 1991/92 to 1992/93. This can most probably be viewed as a sign of the overall economic recovery taking place since the policy reforms of the transitional government.

Table 3.1.4 Important export commodities

Export products	1991/92 (in Ethiopian birr)	1992/93 (in Ethiopian birr)
Coffee	168.324	536.982
Hides and skins	58.645	134.515
Chat	5.073	65.727
Sugar and molasses	1.759	5.090
Pulses	386	4.050
Beeswax	657	1.917
Crude oil	18.826	30.308
Other exports	27.115	22.225
Total export earnings	279.026	800.814

Source: bfai, 1995

Ethiopia's livestock population is the largest in Africa. In both of Ethiopia's main farming systems, the highland mixed crop-livestock production system and the lowland pastoral livestock production system, livestock plays an integral part (Gryseels and Whalen, 1984). Likewise the livestock sub-sector is an important component in the nation's agriculture. It provides the major traction power in agriculture and farm yard manure for enrichment of soils. Hides and skins and beeswax are important export earnings for the country (CSA, 1996). Livestock contributes to 16 percent of the GDP and 30 percent of agricultural GDP. The main livestock export products, hides, and skins, accounted for 12-16 percent of the total value of exports in 1984-88. All livestock exports, including beeswax, accounted for 14-18 percent of total export earnings in 1988-1993 (FAO, 1996b).

The total number of livestock population is about 55,17 million heads according to the Central Statistics Authority (1996). The share of cattle, sheep, and goats is about 30 million (54%), 12 million (21%) and 10 million (17%), respectively, additionally 26 million head poultry, 7 million equine and 1 million camels are found in Ethiopia. Almost all types of cattle, sheep, and goats are of indigenous type (CSA, 1996).

3.1.3.3 Rural Welfare and Child Nutrition in Ethiopia

Consistent with its low per capita income and the resulting general poverty, social indicators as depicted in Table 3.1.5 for Ethiopia show that infant and maternal mortality rates are high, life expectancy is low, and adult illiteracy and primary school enrollment stands below average, when compared to other low income African countries.

Table 3.1.5 Comparison of selected social indicators

		Ethiopia	Tanzania	Kenya
Indicator	Period			
Infant mortality rate (per 1000 live births)	1994	120	59	84
Maternal mortality ratio (per 100000 live births)	1989-95	1528	646	748
Life expectancy at birth (years)	1993	49	51	59
Primary school enrollment (% of age group)	1993	23	91	70
Adult illiteracy (%)	1995	65	22	32

Source: World Development Report, 1996.

Women and children, who constitute about three-quarters of the population, are found to be the most vulnerable members of society from an economic as well as a social perspective. UNICEF describes the situation of women as such, complaining, " [...] they lag behind men in their participation in public life and are the most vulnerable, weak and burdened population groups. They lack decision-making power and have little or no education, leading to a low level of consciousness, low participation in the limited health services, and low income gender-based labour. They also lack appropriate technologies that ease their daily work burden and access to productive assets. In addition they are negatively affected by harmful traditional attitudes and practices buttressed by legal institutions." (UNICEF, 1993, 15). UNICEF also points to the fact, that children are highly valued among all ethnic groups, but harmful traditional child rearing attitudes and practices are widespread.

With 47 percent of all pre-school children underweight[5] (low weight for age) and 64 percent stunted[6] (retarded growth) (NNSS, 1992), indicators reflecting the nutrition situation of children in Ethiopia appear bleak. Their underlying causes are not easily traceable, therefore the general circumstances under which children in rural areas of Ethiopia are living shall be scrutinized below.

The latest information on the human nutrition situation of Ethiopia comes from a national survey undertaken in 1992.[7] Probably the most remarkable results of the 1992 survey are that Ethiopia is among the countries with the highest prevalence of malnutrition in the world and that this trend has been worsening over the recent past, despite the growth of the national economy. The results also challenge the view that malnutrition can primarily be seen as a problem of supply on the national, regional, or household levels. Regions with food surpluses exhibit the highest incidence of malnutrition (Pelletier et al., 1995).

The survey indicates a very high incidence of chronic malnutrition, indicated by the prevalence of stunting in children for all regions in the country. Between the age of 6 months to 56 months 64.2 percent of the children in rural areas are stunted. Within the countries for which UNICEF holds comparable data, this is the highest prevalence of malnutrition after Bangladesh and Mauritania (UNICEF, 1993). Acute malnutrition, indicated by the prevalence of wasting[8] (low weight for height), is less common with an average of 8 percent for children age 6 to 56 months. Wasting has its peak of 11,7 percent in young children age 12-23 months. This is likely related to the weaning of children at this age. This is a typical picture for most populations, but exhibited to a higher extent in Ethiopia. The three indicators of child nutrition are illustrated in Diagram 3.1.1, which shows that differences between boys and girls are not notable.

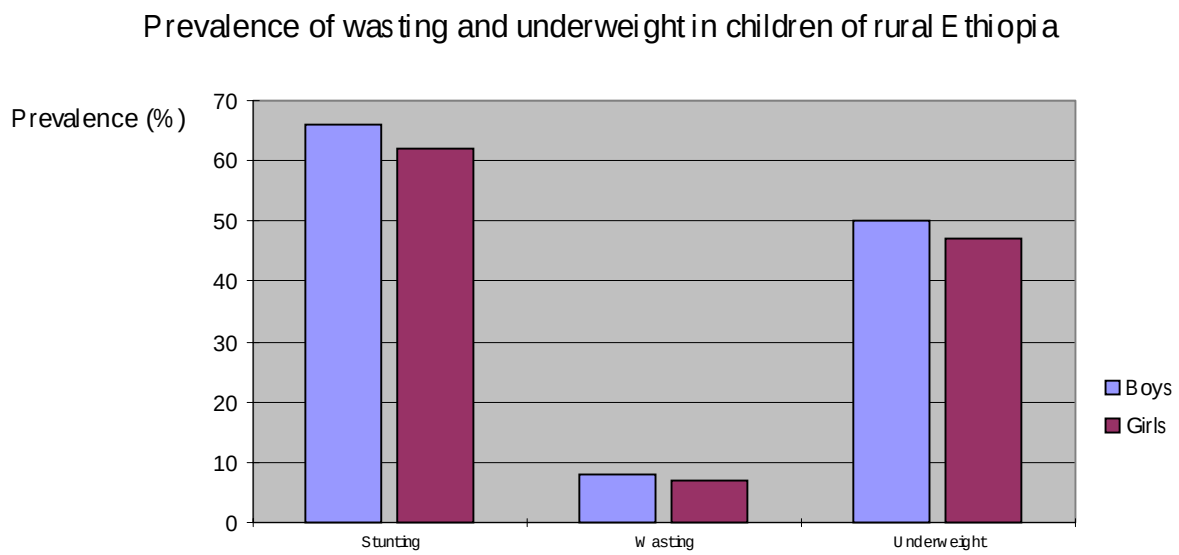
[5] The prevalence of underweight is derived from a weight-for-age measurement that is put into relation to a reference population. For further explanation see section 4.2.2.

[6] The prevalence of stunting is derived from a height-for-age measurement that is put into relation to a reference population. For further explanation see section 4.2.2.

[7] This survey was part of the National Nutrition Surveillance System (NNSS), conducted as a multisector approach and supported by a number of international agencies. The need for the NNSS is evident in the repetition of famines related to food-shortages caused by draughts and the persistence of malnutrition associated with poverty. The aim was to provide information for nutrition long-term planning and policy design. It was not only an assessment of the present situation, but also examined changes over time to identify some of the most important causes of malnutrition in Ethiopia (NNSS 1992).

[8] The prevalence of wasting is derived from a weight-for-height measurement likewise put into relation to a reference population. For further explanation see section 4.2.2.

Diagram 3.1.1



Source: NNSS, 1992.

A comparison of results from the nutrition survey in 1983 to the recent survey of 1992 unmistakably shows a decline in the nutritional status of children over the last decade. This is true for all parts of the country, even regions with the highest investments into infrastructure, and which are characterized by a food surplus (Pelletier et al., 1995).

When households were categorized by their principal farming or main economic activity, it was found that the children of the largest segment of the population, namely 'cereal growers', 'cereal plus roots growers', and 'cereal plus cattle growers', have a high incidence of malnutrition with a prevalence of stunting around 65 percent. Children of coffee growers have the highest prevalence of chronic malnutrition with up to 74 percent among large scale producers, whereas children of civil servants, growers of chat and cattle raisers have the lowest prevalence of chronic malnutrition (52 percent). There also exists a negative association between the size of cultivated land and the prevalence of stunting and wasting among children. This is so across all farming systems except for cash crop farmers (NNSS, 1992). Therefore it can be concluded that malnutrition is generally greater among small scale farmers.

Evidence exists supporting the assumption that malnutrition has its causes in early infancy. There is variability of stunting by age with a noticeable high incidence among infants between 6 to 12 months as indicated in Table 3.1.6.

Table 3.1.6 Prevalence of stunting by age groups

	Children's age group		
	6-12 months	12-23 months	24-56 months
Prevalence of stunting (%)	56,5	72,7	63,0

Source: NNSS, 1992 (modified).

The high incidence of stunting at an early age, but no significant further increase in later childhood, coupled with birth weights, which are low but still average for African standard, further supports the assumption that causes should be dated to early infancy (NNSS, 1992).

The practice of prolonged exclusive breastfeeding beyond 4 to 6 months may be an important contributing factor to the high rates of stunting seen in young children. A positive correlation is documented between prolonged exclusive breast feeding and stunting among children 6 -23 months (NNSS, 1992). Furthermore, it was found that complementary food, commonly introduced too late, is often additionally inadequate in quantity, of poor quality and contaminated. Such diet can lead to increased morbidity, particularly diarrhoeal diseases, that further reduces the nutritional reserves of the child. Moreover, across all ethnic groups it has been observed, that breast milk is not given immediately after birth (UNICEF, 1993). Instead, fresh butter, juice of enset, cold and warm water, black incense etc., are given as a "laxative" to the baby, because the traditional believe is that the stomach of the newly born needs to be cleansed. This practice deprives the baby of the necessary colostrum, which is rich in nutrients and immune components and protects the infant from infections.

Some of the measurements indicate that male children are more affected by malnutrition than female children, but the difference is not large. Results of an analysis considering religious and ethnic background of the mother does not reveal significant evidence for preference of resource allocation of girls over boys (NNSS, 1992).

Four types of malnutrition afflict large parts of the population in general and particularly children in Ethiopia. These are protein-energy-malnutrition (PEM), vitamin A deficiency, anemia and endemic goiter. Children also suffer from a high burden of disease. Most commonly observed symptoms are diarrhea and fever. 12,5 percent of all children suffer

from diarrhea and 22 percent from fever at any given point in time. The areas with the highest incidence of disease are associated with unclean water such as from rivers, springs or unprotected wells (NNSS, 1992).

Vitamin A deficiency is a major public health problem, manifested through various symptoms, which can eventually lead to blindness. In a nation wide study bitot spots were seen in 0,87 percent of all children. Serum retinal levels were in the ”deficiency” range in 16 percent and ”low” range in 44 percent of all children. This data indicates that 73 000 children under six years of age exhibit eye manifestations and an additional five million children have subclinical vitamin A deficiency status. The immediate causes of vitamin A deficiency are low dietary intake of vitamin A rich foods, mal-absorption, concurrent infections, and parasitic infections (UNICEF, 1993).

3.2 Ethiopia’s Dairy Sector

3.2.1 The Market for Dairy Products in the African and Global Context

Ethiopia is currently importing dairy products, such as powdered milk and butter oil, and dependence on dairy products is growing. The estimated annual growth rate of milk consumption available for the 10 years preceding 1988 was 2,5 percent, while growth in production during the same period of time was only 1,4 percent. An initially low import dependence grew from 4,1 percent to 12,8 percent during that period (Shapouri and Rosen, 1992). Staal (1997) remarks that although most of these imports occurred through food aid programs now curtailed, the consequence of maintaining this trend would be a growing financial burden - even more when considering projected rising world prices for dairy products.

Staal (1997) provides a comprehensive summery of the present situation. He explains, that world production of liquid milk is presently declining. From an average of about 536 million metric tons in 1988-90 it fell to about 518 metric tons in 1993. In Africa, production fell from 13 million metric tons in 1988-90 to 11 million metric tons in 1993. This was largely due to drought in Southern Africa, the largest production area. World prices for milk powder remain highly volatile, as consumption patterns shift. While a trend of lower consumption of milk fat is observed for the industrialized world, milk consumption in economically developing countries is rising. The overall trend, however, is towards rising nominal prices. FAO expects that milk production levels will continue to fall, and that nominal prices will continue to trend upwards. At the same time demand for dairy products in Africa is increasing. This is perceived as a result of continued urbanization of the continent, income growth among certain segments of the population, and changes in diets (Shapouri and Rosen, 1992). Staal

(1997) concludes that opportunities for African dairy producers in general exist and may even grow in the future. With Africa's largest livestock herd, the potential for profitable dairy production in Ethiopia is substantial. Nevertheless, the current situation is characterized by the inability to maintain per capita dairy production levels, which point to significant weaknesses in the milk production and marketing system. These weaknesses stand in contrast to existing potential. Neighboring Kenya for example, which shares some of Ethiopia's highland characteristics, is largely self sufficient in simple net quantity terms.

Typical for the general situation in East Africa, likewise in Ethiopia, smallholders play the most important role in milk production. In Ethiopia smallholders account for 75 percent of commercial liquid milk production and even a higher proportion of national milk production (Staal, 1997).

3.2.2 The Evolution of the Dairy Sector and the Current Policy Environment

The changes in the political system and the government in 1991 have also affected the dairy sector, particularly its structural and institutional organization. Structural adjustment in Ethiopia nowadays aims at largely liberalized markets and privatization of formally state owned enterprises. So far, results of this development are private investments into the previously parastatal breeding stations and dairy farms. A greater incorporation of the informal dairy sector into the formal is intended and farmers are not any longer obliged to organize in cooperatives, instead they are permitted to establish free "user groups". The Addis Ababa Dairy Producers Association (AADPA) was formed in 1991 and is now the largest such "user group" with considerable political influence. The change has also affected milk prices and the availability of veterinary and a.i. services. Government officials designed a general policy outline to the Ministry of Agriculture proposing to:

- Set up a dairy board with broader mandate to oversee all aspects of dairy production and marketing, including regulation of both producer and consumer prices, with more frequent reviews of prices.
- Increase aggregate milking herd size.
- Increase milking productivity, with the provision for more research towards this end.
- Establish quotas and import duties on dairy products.

Staal (1997) concludes that opportunities for smallholders seem better then ever. Nevertheless, changes take place only gradually, and a brief review of the past policy environment and the evolution of the dairy sector will facilitate to make projections about future developments in dairy production and marketing opportunities.

The growth of large indigenous commercial farmers in peri-urban areas around Addis Ababa started under the imperial regime of Emperor Haile Selassi. The owners of these farms took advantage of their assured feudal land tenure rights and had at their disposal a large land resource. They also benefited from subsidized milk collection and free markets for feed and other inputs and economies of scale in production and marketing. At that time smallholders had no access to improved cattle and suffered under the feudal system with its inequitable distribution of land. The subsequent period under the socialist regime was characterized by nominal, but not actual support for smallholders. The profitability of the large, then state owned farms gradually declined. Smallholders were negatively affected by policies which brought about land tenure uncertainty, feed supply restrictions, and reduced formal producer prices for dairy products. As a result production shifted to urban producers who were able to bypass formal marketing outlets and sold milk directly to consumers. The supply of milk to the formal market shrank to well below processing capacity, and was derived mainly from the large but unprofitable state dairy farms (Staal, 1997).

The new government has opted for ”The Livestock Sector Development Project”, planned by the FAO in 1993, including a dairy component with the stated objectives of

- increasing milk production in areas with market access (peri-urban areas),
- increasing small farmer income, and
- improving nutrition of rural and urban populations.

The strategy to be followed is to significantly increase the number of improved cattle, simultaneously establishing new smallholder dairy producers and to support further forage development. 3 350 production units are proposed, of which some 65 percent are projected to be one-cow units, implying a strong orientation towards the smallest producers. A remarkable change in Ethiopian dairy policy is signaled by an effort to assist the establishment of small private processing enterprises. Family-based processing units are envisaged to be set up to produce butter for local markets. Parallel to this the establishment of user groups would be encouraged to assist the processing units and to organize the marketing of liquid milk (Staal, 1997).

3.2.3 The Dairy Market of Addis Ababa and the Periurban Region

3.2.3.1 Demand for Milk and Dairy Products

Milk, *kebe* (Ethiopian butter), and *ayib* (fresh cheese) are the traditional dairy products produced, consumed and traded throughout the highlands of Ethiopia. They constitute regular dishes in the diet of most Ethiopians. *Kebe* is a vital part of the Ethiopian cuisine,

commonly available at three different stages of rancidity: *lagga kebe* (fresh), *mekakelegna kebe* (half-fresh), *bassal kebe* (rancid). Besides its importance for human consumption fresh *kebe* is also used for cosmetic purposes, especially for women's hair, but also as medicine. Considering aggregate dairy consumption measured in liquid milk equivalents, *kebe* constitutes the most important dairy product, but milk consumption is likewise very common. *Ayib* is part of some dishes particularly served together with the traditional food *injera*. Consumption of *ayib* is common, but less frequent. In Addis Ababa a variety of other dairy products is available in shops and supermarkets, they do not constitute regular Ethiopian dishes and therefore have a smaller market share. These products are different types of cheese, *irgo* (fermented milk), and ice-cream (Duteutre, 1993).

In their survey, Hurrissa et al. (1993) estimate the per caput liquid milk consumption of a sample of Addis Ababa milk purchasing households in 1992 to be some 40 l/head/year in 1992 (equivalent to 207 l/household/year). CSA (1992) computed per caput liquid milk consumption of the city based on the aggregate quantity of milk supplied to Addis Ababa and a population of 2,1 million inhabitants to be 8,3 l/head/year[9]. This is lower than the estimated national per caput consumption of 13 l/head/year. The lower consumption level in the capital is believed to be attributable to supply shortfalls. Another estimate by Hurrissa et al. (1993), assuming a milk supply increase to the Addis Ababa milk market of about 15 percent and 40 percent of all households able to purchase 207 l/year (equivalent to 40 l/head/year), projects an average excess demand of 43 000 l/day.

Households spend a considerable part of their income on dairy products, in particular on *kebe*, milk, and *ayib*. Relating consumer household expenditures to household aggregate income, between 4 to 26 percent of monthly income are spend on dairy products. Expenditure shares for poorest households are highest. They spend the substantial portion of up to 26 percent of their income on dairy consumption. The average expenditure share of all households is highest for *kebe* and lowest for *ayib*. Poorest households spend 14,5 percent of their income on *kebe*, richest households spend about 2,5 percent of their income on *kebe*. Looking at the actual amounts of dairy products purchased, low-income groups can afford to buy about 9 kilogram of *kebe* per household per year, while richer households consume about 45 kilogram of *kebe* per year. The average annual household *kebe* consumption in Addis Ababa in 1992 was about 23 kilogram. The average *ayib* consumption is about 10 kg per household per year (Hurissa et al., 1993).

[9] The difference between the two estimates most probably results from the fact that a large part of the population is not in the position to purchase milk.

Hurissa at al. (1993) record average consumer prices for milk, *kebe*, and *ayib* in September/December 1992 in Addis Ababa as:

- 1,59 birr/l milk,
- 25,00 birr/kg *kebe,*
- 5,00 birr/kg *ayib.*

3.2.3.2 Supply of Milk and Dairy Products

Indicated in Table 3.2.1, Hurissa et al. (1993) estimate the daily supply of liquid milk to consumers in Addis Ababa at about 48 000 l/day. This includes domestic production as well as imports of butter oil, skimmed milk powder, and full cream powder. In 1987 the imported value of 76 000 MT of liquid milk equivalent was $US 13 million. In 1991/92 23 percent of supply were imported (about 11 000 l/day) and 77 percent were produced domestically (about 37 000 l/day).

Table 3.2.1 Estimated daily fluid milk supply to Addis Ababa (1991/92)

	Supply (liters/day)	Market share (% of total)
Domestic production	37 067	77
Imports	11 213	23
Total	48 289	100

Source: Hurrissa et al., 1993 (modified).

The majority of the 37 000 l milk produced daily in Addis Ababa and its periurban surrounding is supplied by private producers. Only 5 percent of all milk is produced on state farms. Among the private producers small urban producers supply more than half of the total, 52,7 percent. Small periurban producers are the next most important group, supplying about 20 percent. This amounts to a market share of more than 70 percent by smallholders. With some of the lowest milk yields and often with only one cow, smallholder dairy producers in Addis Ababa and the periurban region are able to supply most of the milk marketed. The remaining 22,5 percent market share is supplied by large urban and periurban dairy farmers (Staal, 1997).

In Ethiopia two market systems, the formal state controlled milk market and the informal unregulated milk market coexist. In terms of quantities of milk marketed through these channels the informal market is the more important market. The majority of milk producers sell some 75 percent of all liquid milk marketed through informal channels as raw milk unregulated by the authorities (Debrah, 1991). This is to avoid taxation and quality controls,

but equally important to obtain the higher milk price paid by customers in the informal market. Sales here include direct sales to individuals, sales to institutions, sales to private raw milk traders, to retail outlets, and to informal dairy processors, whereby direct sales by producers to consumers constitute the most important manner in which milk is marketed in the Addis Ababa milkshed, comprising 44,1 percent of total milk marketed (Debrah, 1991). These sales normally involve an informal contractual arrangement whereby a producer agrees to supply a certain quantity of milk daily to the consumer. The second most important manner in which milk is marketed are direct sales by producers to institutions such as restaurants, hotels, and offices. They are following the same sort of contractual agreements and make up 26,9 percent of total milk marketed. These two types of direct sales largely define the dairy market, as they represent 71 percent of total milk marketed in the Addis Ababa milkshed. As a result of this, post-farm dairy activities play a relatively small role overall, because direct sales do not involve processing such as pasteurization, homogenization, or packing (Debrah, 1991). For this reason consumers are aware that they need to boil the milk themselves before they can drink it.

The only formal outlet for liquid milk is the Ethiopian Dairy Development Enterprise (DDE), the government parastatal. Despite market liberalization efforts and privatization of a number of state owned operations the DDE has retained its role as the primary actor in the formal dairy market until this day, although changes have been proposed which may diminish that role in the near future. The DDE is still the only enterprise that operates a system of milk collection and cooling centers along all five major roads radiating from the capital. Farmers bring their morning milk to these simple collection centers where it is weighted and tested for adulteration. Records of milk supplies are kept and payment is made monthly. The DDE operates the Shola milk processing plant, the only milk processing plant in the country, situated in the western outskirts of Addis Ababa. With a daily capacity of 60 000 l/year, the plant pasteurizes, homogenizes and packages milk into 0,5 l plastic bags. Additional, dairy products such as table butter, cream and ice-cream are produced. Some 83 percent of plant intake, however is processed as liquid milk. The plant has no facilities for drying of milk.

An official fixed producer price is paid by DDE collection centers. Until 1997 it was still 1,0 birr/l, raised to that amount from 0,65 birr/l in May 1993. In 1993 daily intake by the Shola plant averaged less than 10 000 l/day, or less than 1/6 of capacity. The DDE milk output is sold at highly subsidized rate either in bulk to institutions, or retail through DDE shops,

kebele[10] shops, or private outlets. However, the milk processed by the DDE comprises only 12,6 percent of the wholesale liquid milk marketed in the Addis Ababa milkshed.

Although the fixed producer priced paid to farmers who sell their milk to the DDE collection centers is much lower than the average milk price of about 1,50 birr/l paid in the informal market, many periurban producers depend on this outlet. The DDE in this case often acts as a buyer of last resort. Many large farmers depend on the reliable delivery to DDE collection centers, because in this way their large quantities of milk can be sold with lowest transaction costs, especially during the fasting period and on the two fasting days every week, which generally create an unstable demand. The small periurban producers sell some 20 percent of their output to the DDE (Staal, 1997). Besides sales to individuals and institutions through the informal market in small population centers, where hotels and restaurants in particular constitute an important outlet for small periurban producers, they rely more than any other group on home processing of milk output, primarily into butter, which is sold to traders. This allows excess production to be conserved and marketed economically.

In his analysis of the Ethiopian dairy sector Staal (1997) confirms that Ethiopian smallholders have a strong comparative advantage in dairy production due to low land and labour costs if, however, the domestic milk market is exposed to world prices. The import parity price is 2,25 birr/l and the export parity price is 1,40 birr/l. Both are well above the official producer price of 1,00 birr/l paid by the DDE. Related to the comparative advantage in smallholder dairy production his results reveal the private profitability in periurban dairying with above-normal profits even for the smallest production units, attesting higher returns to factors in dairying than in alternative domestic activities under current market conditions. Moreover he points out that further development of dairying in Addis Ababa and its surrounding region cannot be expected to continue to be dominated by backyard urban producers. Dairying must move out of the city and operate directly on the land resource base. This will require producer price incentives coupled with stable market outlets, provided by the formal collection system in periurban and rural areas. An alternative to this is the development of the informal processing, perhaps operated by small dairy cooperatives. Besides their attested profitability in dairy production periurban smallholders face problems such as high animal mortality rates, difficult access to veterinary and a.i. services, difficulties with land tenure laws, and scarcity of feeder roads.

[10] Kebele refers to the smallest unit of town administration. In kebele shops basic foodstuffs and household goods are sold at subsidized rates.

3.3 Technological and Institutional Change for Dairy Intensification in the Ethiopian Highlands

Smallholder mixed crop-livestock farming accounts for all but a small percentage of agricultural land use in the Ethiopian highlands, including the periurban region around Addis Ababa, where a negligible number of dairy producing state farms and some commercial dairy farms are located. Described in the previous chapter, the capital's dairy market heavily relies on smallholder dairy production in and around Addis Ababa. "Periurban" in this context is defined as the region, where farmers have access to the dairy market of Addis Ababa, particularly the fluid milk market. This access to the fluid milk market is ensured wherever farmers live in close enough proximity to DDE milk collection centers to carry their produce there. Alternatively (and traditionally) *kebe* and *ayib* are traded by smallholders. These products do not rely on technically sophisticated collection systems and reach Addis Ababa's customers even from remote areas. Besides this periurban characteristic - the connection to the market for liquid milk - the areas surrounding Addis Ababa still represent a typical rural environment with poor infrastructure, limited access to the service sector, and low school attendance.

In the following section the prevailing traditional smallholder mixed crop-livestock systems in the Ethiopian Highlands will be described. Subsequently, evidence about changes occurring after smallholders adopted intensified dairy farming practices is presented. The focus will remain with the issues related to the allocation of incremental dairy income, food consumption, and the general state of smallholder child nutrition.

3.3.1 Characteristics of Traditional Smallholder Farming Systems

3.3.1.1 The Farming System

Ruthenberg (1980) defines the farming system prevalent in the highlands of Ethiopia as one of the most evolved traditional ley systems in the tropics. It is classified as a regulated ley smallholder system that involves crop rotation, including not only intensively grazed grass fallows, but also teff (*Eragrostis abyssinica*), a grass type crop producing seeds for human consumption and valuable straw for cattle. Nevertheless, growing pressure on the land resource induced a change in system to a mainly permanent cultivation in present days.

Typically farmers in the Ethiopian highlands rely on rainfed agriculture producing cereals, pulses, and livestock, using few external inputs. Farming is mainly based on family labour and animal draught power (Gryseels, 1988). The general characteristics of the smallholder mixed crop-livestock farming system are exhibited in the Ethiopian Highlands (Winrock International, 1992).

Apart from these general characteristics smallholder farming systems in the Ethiopian highlands are anything but uniform. The remarkable diversity in the topography with its undulated plateaus and steep falling gorges and the wide ranges in altitudes creates varying farming conditions on relatively small territory (FAO, 1996a). Different altitudes affect local climates, causing hazards such as hail and lower temperatures in higher altitudes, thus reducing the number of growing days. This influences the relative importance of crop and animal species. In the high potential agricultural zones, especially between 1 500 and 2 300 meters a.s.l., the densely populated *Weyna Dega*, cattle is kept for draught purposes as well as to provide meat and milk. Here land is intensely cultivated with virtually no arable ground left fallow. In higher altitudes farmers keep large sheep herds and cattle, of which the latter predominately supply draught power. The area is less densely populated and about one third of the arable land is left fallow in any season. In lower altitudes goats dominate the animal herd (Gryseels , 1988).

Farmers depend on the *meher* season - the long rains from June to September when 70 to 80 percent of the annual rain falls - for crop planting. The *belg* - the short rains occurring from February to May - are used for soil preparation. *Belg* rains are less reliable and therefore only occasionally used to grow crops. Nevertheless, the short rains are very important to break the heavy soils using the wooden plough, the *maresha*, drawn by a pair of oxen (Gryseels, 1988). Teff, confined in its distribution to the Ethiopian highlands, is the main crop, supplemented by maize in the intermediate altitudes and wheat, barley, and pulses in the higher altitudes. Continued soil degradation, but also the heavy cloud cover during most of the rainy season result in relatively low yield levels (Ruthenberg, 1980). Table 3.3.1 presents average yields of the dominant crops.

Table 3.3.1 Average yields for main crops

	Teff	Wheat or Barley	Beans
Yield (t/ha):	0,5	0,74	0,69

Source: Ruthenberg, 1980 (modified).

Ruthenberg (1980) describes teff as the preferred crop, even though returns per hectare are lower then that of wheat or barley, and labour input tends to be higher. It has a pronounced

consumer preference and receives a higher price. Teff is a more reliable crop and less sensitive to waterlogging than other cereals. Furthermore, the straw is a valuable roughage, low in lignin and much more easily digestible than wheat or barley straw. Storage losses with teff are low and in crop rotation teff is appreciated before wheat and barley, because its high weeding effort produces a ”clean field”.

3.3.1.2 Land Tenure

In this environment with its salient differences, generalizations can only be taken with caution, and it is therefore difficult to provide any meaningful information on household size and the amount of farmland available to households. Ruthenberg (1980) still reports average land size to be 5,5 ha per household in 1973. Since then there has been redistribution of land for a number of times. Gryseels (1988) reports average land size to be 2,35 ha for the Debre Berhan area, ranging from 0,7 ha to 9,7 ha. Farmers in the Highlands commonly differentiate between grazing land and cropland. But farmers in Ethiopia do not own the land they till, farmers only have ”user rights”. Likewise land cannot be sold, and ”user rights” can only be inherited by relatives. Newly formed families receive their plots for farming from the peasant association (PA) who is responsible for land distribution. The area allocated to a household depends on family size, available land in the PA, population density, and policies of the local PA (Gryseels et al., 1988). After the war in 1992 all land was redistributed for the second time after 1974, mainly to be able to allocate land to returning soldiers. Pankhurst (1993) found, that live in constant fear to loose part of their land to these redistributions. It is therefore difficult to acquire accurate information about the size of plots cultivated. Related to this insecurity in tenure rights, remarks have been made by farmers that they were reluctant to invest into soil quality.

3.3.1.3 The Farm Household

The majority of smallholder households in the Ethiopian Highlands consist of the basic family unit - husband, wife, and their children. Additionally close relatives, especially elders, and unmarried siblings share one roof if they do not have their own household. The farm family is the primary source of labour force available for farming activities (Gryseels, 1988). The potential labour practically available depends on size and composition of the household, since males and females and different age groups do not have the same responsibilities, neither working capacities. Men are usually responsible for land preparation, using oxen for ploughing. Women are responsible for planting and weeding. They are also responsible for a major share of the livestock work such as feeding, watering, and milking (Pankhurst, 1993). Average household size in the Debre Libanos and Selale *Awrajas*, a periurban region in the high potential cereal-livestock production zone north of Addis Ababa, is reported to be 6,9 persons (Teklu, 1997). Unique for the Ethiopian highlands is the strict observance of

religious holidays by the followers of the orthodox church. On Sundays and a number of other religious holidays any cropping activities such as ploughing, weeding, harvesting, and threshing are forbidden. This limits the fieldwork by approximately 150 to 200 religious holidays per year (Gryseels, 1988).

Pankhurst observed (1993) that the majority of households participate in traditional manners of labour exchange and work parties. This is practiced at the peak of agricultural seasons, primarily during the harvest, but also during weeding and ploughing to overcome labour shortage. *Wenfel* is an arrangement whereby labour is exchanged for labour. Men come together with their pairs of oxen and work together on one person's fields or women come together to join in weeding each others fields. Another important arrangement is *debo*, for which a person prepares food and drink and invites 10 to 20 people to come and work on his or her plot of land. Besides these arrangements it is also not uncommon to employ a permanent labourer or a herds-boy.

3.3.1.4 The Livestock Enterprise

In the Ethiopian Highlands livestock is of crucial importance to the farming system, which benefits from a high level of crop-livestock integration (Gryseels and Whalen, 1984). Livestock supports the cropping system in various ways, furthermore it provides cash income, it serves as a security and it is a means for investment. These important aspects of the smallholder economy are, moreover, reflected in the substantial role livestock has for household food security. Gryseels and Whalen (1984) identify livestock in the mixed crop-livestock system to particularly provide three basic elements of household food security:

1. A direct contribution in the form of food;
2. A productivity enhancing contribution of animals, especially oxen, to crop production;
3. The provision of cash income, which is used to buy productivity enhancing inputs.

Almost all farmers own livestock, usually local breeds, and a typical farm inventory consists of two oxen, a cow, a calve, sometimes a few sheep, a donkey and some poultry. But there is a wide variation of livestock ownership observabled (Gryseels, 1988). Particularly the availability of oxen draught power is a strong factor determining farm grain production. Oxen power can be used to gain access to the use of further land on a share-cropping basis, and it can be used as a means to obtain additional agricultural labour. Gryseels (1988) found the level of oxen ownership to have a significant effect on both, the yield per ha of cereals and total area cultivated. In his study, farmers with two oxen produced on average 63 percent more cereal grains than farmers with no oxen and 19 percent more cereal grains than farmers with one oxen. The existing traditional arrangements are explained in Pankhurst

(1996), through which farmers who own none or only one oxen can loan oxen. The most common arrangement, called *igni,* involves the commitment of the borrower to three days labour on the owner's field and two days labour on the borrower's field. Another arrangement, called *minda*, is a deal in which the owner of the ox is given a certain amount of the produce (around half to two thirds) in return for the service. *Yegerafi* is an institution, according to which the ox is trained in the first year by the borrower to make it suitable for ploughing. In the second year it starts ploughing, and in the third year it is returned to the owner along with 10 *kuna* (about 100 kg) of grain (Pankhurst, 1993).

Gryseels (1988) explains that the majority of household cash income is provided by livestock and livestock product sales, farm gross margin (by 53 percent) and gross value of production (by 46 percent) heavily depend on livestock. Trade of animals, particularly cattle and sheep, is the main source of cash income. Together they provide 98 percent of all cash income. The main outputs of cattle are intermediate products, used as inputs into the crop enterprise, such as draught power for land cultivation and crop threshing, and manure for fertilizer and household fuel. When these intermediate functions are valued, livestock contributes on average 60 percent to the gross farm margin.

Livestock are also of prime importance in providing economic security and they are a mode for investment to the household. Wealth is largely stored in the form of livestock, which are perceived by farmers as the best form of reproductive investment. Wealth is measured in the size of herds. Profits from the sale of grain or trade are commonly reinvested in the form of livestock and at the same time animals are disposed of to meet all kinds of needs. Therefore farmers constantly seek to increase their herd size (Pankhurst, 1993).

3.3.2 Subsistence and Food Consumption

Smallholder farming in the Ethiopian Highlands generally is characterized by a high level of subsistence production. Most of the cereals - on average 90 percent of production - are home consumed and only a small amount of grain production is traded (Gryseels, 1988). In UNICEF (1993) it is stated, that rural households in Ethiopia suffer from their high dependence on subsistence production, which renders them fragile to household food insecurity in the face of reoccurring droughts, declining soil fertility, and insufficient storage facilities. A large number of rural households are chronically food insecure, many more experience transient food insecurity, and an even larger number are at high risk because they have to use a disproportionate part of their resources to maintain household food security. Only 10 percent of Ethiopia's rural households are regarded as food secure.

Gryseels et al. (1984) reported average annual gross cash income estimates in US$ (years 1979 to 1983) as depicted in Table 3.3.2. From these numbers the substantial contribution of the sale of live animals and livestock products is to household cash income becomes again apparent:

Table 3.3.2 Average annual gross cash incomes of smallholder farmers around Debre Berhan

	Average annual gross cash income			
	Cereals	Pulses	Livestock products (milk, meat, manure, hides)	Live animals (reinvestment was deducted from gross sales)
Income in $US:	14,6	6,0	37,0	107,6

Source: Gryseels et al., 1984 (modified).

The staple food for farmers in the highlands if Ethiopia is *injera*, a ”pancake” like bread made from fermented dough. Preferably *teff* flour is used as the main ingredient, but other cereals like barley, sorghum or millet are mixed in as well. If farmers are able to provide for it, a sauce is consumed with injera, which usually consists of pulses, mostly lentils, horse beans or field peas. Otherwise injera is simply served with *berbery* or soaked in a soup-like liquid to give it some taste. On special occasions and holidays sauces including meat might be prepared. More than 150 fasting days over the year restrict people from eating animal products on those days, but even on the remaining days meat consumption is very low, because farmers usually cannot afford to buy it. Dairy products are highly valued in the Ethiopian diet, especially in the form of *kebe*, *ayib*, and fresh milk. Households who own dairy cows will give priority to children if fresh milk is available for home consumption, but likewise adults drink milk, if available (Pankhurst, 1996; Gryseels et al., 1984).

There is no information available on the energy, protein or fat consumption levels of smallholder households in the Ethiopian Highlands. Nevertheless, two factors are known to lead to seasonal food shortage for large parts of the population living in the rural highlands. One is connected to the fasting rules of the Ethiopian Orthodox Church, which oblige everyone above the age of ten to a diet that must not contain any animal protein except fish on Wednesdays and Fridays, and during the eight weeks of fasting before Easter, and the second and third week in August. Besides this demand factor causing seasonality, a supply factor exists. In the pre-harvest period, the *meher* season, the energy balance is likely to drop to negative, since the energy demand of field activities is high and simultaneously consumption is low. The latter occurs because grain stocks are emptied and grain prices are high at this time of the year (Gryseels et al., 1984).

3.3.3 Intensification: Integration of Crossbred Cows into the Farming System

3.3.3.1 The Peri-Urban-Dairy-Technology-Project (PUDT-Project)

Currently dairy production from exotic and cross-bred animals is insignificant among smallholders in Ethiopia (Staal, 1997). To support dairy development, previous governments have been carrying out crossbreeding programs, but only since the present government is in power dairy intensification projects are targeted at the smallholder sector. Currently a large project is undertaken as part of the overall dairy development program by the Ministry of Agriculture (MoA) in collaboration with the Finnish International Development Agency (FINNIDA). Project farmers of four different administrative zones around Addis Ababa are assisted to integrate crossbred cows into their farming enterprises.

The International Livestock Research Institute (ILRI) (then ILCA) is carrying out on-farm research to study opportunities and constraints of periurban smallholder dairy technologies (PUDT) in the Ethiopian highlands since the 1980s. One of the latest efforts of the institution aims at providing effective means for the utilization of animal power in small scale farming, thereby further increasing whole-farm productivity and creating a more sustainable farming system is the use of crossbred dairy cows for traction and milk production (Zerbini and Gebre Wold, 1996). This is a joint research of the Ethiopian Institute for Agricultural Research (IAR) and ILRI. On-farm trials to additionally use crossbred cows for traction have started in 1993. The pilot project is conducted with farmers in the area around the town of Holetta, where an IAR research station is situated.

This present study deals with farmers of the pilot project, but is not explicitly concerned about the cow traction part of the PUDT-Project of ILRI/IAR. It focuses solely on the welfare effects of intensified dairy production using crossbred cows. It is reasonable to assume that the cow traction part of the project does not interfere significantly with this research aim (Larsen, 1997). Generally the PUDT-Project includes the introduction of crossbred cows and complementary feed and management technologies which ensure prolonged lactation periods and higher daily milk yields per cow. To this end a technology package of six modules, depicted in more detail in Table 3.3.3, is provided to farmers.

Table 3.3.3 The six modules of the PUDT-Project:

1. Improved genotype: A pair of cows (F1 Friesian * Boran) with larger body frame and a higher production potential than local cows.
2. Forage package: Farmers are advised to plant a minimum of ½ ha of oats and vetch for hay production each year. In addition a backyard forage has been developed recommending farmers to plant Napier grass, fodder trees (Tagasaste and Sesbania) and fodder beets on their compound.
3. Health package: The project provides veterinary drugs. The health scheme consists of

regular administration of vaccination, de-worming and spraying procedures as well as routine visits to all project farmers. Moreover, emphasis is put on advising farmers to improve hygiene procedures and practice restricted grazing.
4. Breeding package: The scheme consists of heat detection, timely insemination, pregnancy testing (PD) and control of reproductive diseases. All project cows are served with 50 percent Friesian * Boran semen through a.i.. The offspring are being served either with crossbred bulls (50 percent) or with local bulls. The aim is to maintain a population close to 50 percent exotic blood on-farm.
5. Improved management of cows and calves: This package includes areas such as stalling, calf rearing, heifer rearing, crossbred cow management, milking and milk handling, draught work, manure handling, and herd size.
6. Training package: The aim of the training package is to increase farmers awareness of the advantage and constraints of the introduced technology. A complementary objective is to get direct feedback from farmers on the technology adoption process.

Source: Larsen, 1997.

3.3.3.2 The Project Area

The project area is situated in the central highlands between 40 and 70 kilometers to the West of the capital Addis Ababa in the vicinity of two small towns: Holetta and Addis Alem. This region is part of the high potential cereal-livestock production zone. The altitude of this area is around 2600 m a.s.l. and receives an average annual rainfall of 1100 mm (Buta, 1996). According to IAR/Holetta Research Station temperature records, minimum and maximum temperature averaged over a period of 5 years (1968-1972), is 11,6 and 15,3°C, respectively.

The area lies in two *Awrajas:* Dendi and Welmera. It is traditional Oromo land, the administrative Oromya Region (Region 4), also known as Shewa Region. Languages spoken are foremost Oromigna and Amarigna (the official state language). While men mostly know both languages, many women, especially of middle age and older, only speak Oromigna. Pankhurst (1996) describes the region as one that has experienced considerable immigration of Amhara at the end of the last century and of Gurage in more recent times. The population is predominately Oromo although there are significant Amhara and Gurage minorities that have inter-married and have been well integrated. In spite of the population belonging to the Christian Orthodox Church, there is considerable adherence to traditional Oromo believes. Powerful traditional leaders and healers attract large followings. Under current circumstances it is considered very helpful when such traditional institutions are able to assist in bringing about security and controlling theft and lawlessness. Disputes over settlement for example are carried out in traditional ways. Unfortunately there is likewise considerable superstition connected to the traditional believes, expressed in customs, which are harmful to the well-being of women and children with negative consequences for health and nutrition (UNICEF, 1993).

Buta (1996) estimates average household size to be 7,9 persons, which is high compared to the national average of about 5 persons. Expressed in adult male labour equivalents the households posses a labour force of about 5 adult male equivalents. Labour shortage is reported to be commonly encountered especially during the harvest season. A number of households therefore employ a herds boy, a house maid, or an adult male, and most of them take part in traditional labour exchange arrangements. The average farm is reported to have about 24 *timand* (timand is a local unit which is the area a pair of oxen can plough in a day or approximately equal to a quarter of a hectare) of land, 1 to 3 ha of which are grazing land and about 1 ha pasture land. The average cultivated area is about 3,9 ha. Main crops grown are teff, wheat, barley, horsebeans, fieldpeas, sorghum, rough-peas, lentils, and maize. Teff and wheat are occupying about 44 percent of the total land, which corresponds to 60 percent of the arable land in this area. The diversity of crops grown rather represents the reliance on

subsistence production than a security against production risks. Artificial fertilizer is applied to the land, but manure is only used close to the homestead. A typical herd composition of project farmers is three cows, two calves, two heifers, four oxen, four sheep, two goats, and two equine, which adds up to about 11 TLU (Buta, 1996).

Children at the study side suffer exceptionally from eye problems closely related to vitamin A deficiency. In an eye examination undertaken by the Ethiopian Health and Nutrition Research Institute (EHNI) a high incidence of bitot spots and conjunctival xerosis, a pre-cursor of bitot spots, were found in an representative sample of 122 preschool children (EHNI, 1996). The World Health Organization has set a critical value for the prevalence rates of bitot spots, above which vitamin A deficiency should be considered a public health problem (West, 1994). This value is exceeded by a multiple of twenty times in the children at the study site. Most of these types of eye problems are usually reversible when sufficient vitamin A is supplied. As long as children do not suffer from certain health problems, especially intestinal parasites, any increase of the micronutrient vitamin A in the diet will enhance their nutritional well-being appreciably (Gibson, 1992).

3.3.4 Change in Production and Management Characteristics

The magnitude of the initial investment and the fundamental changes that have to take place in order to acquire crossbred animals under the intensification scheme of the PUDT-Project become apparent from the terms and conditions, which the farmers have to agree upon in order to take part in the scheme. These terms and conditions are summarized in Table3.3.4:

Table 3.3.4 Terms and conditions for farmers participating in the PUDT-Project

1. The farmer buys two pregnant cows for 600 birr each. The price represent a considerable incentive since the market value of the cows is estimated at more than double the price offered and the cows are about to calve, significantly increasing their value.
2. The farmer is expected to sell off about two heads of the local cattle in order to be able to pay for the animals and to attain the reducing of herd size by the replacement of more productive animals.
3. The farmer is expected to construct a barn for the cows according to specifications using stone, sand and cement, and wood.
4. The farmer is expected to allocate half a hectare of land to plant oats and vetch as fodder for the cows.
5. The farmer has to cooperate with the enumerators in their daily recording of data for the duration of the project.

Source: Pankhurst, 1993.

Prior to the onset of the project farmers were already well informed about the advantages crossbred cows inherit compared to the indigenous cows. They know that differences in milk

yield are substantial and that the milk can be marketed very profitable in the towns or to the DDE. They are likewise aware of the difficulties attached to the management of crossbred cows. Foremost concerns are the provision of adequate feed and the vulnerability of the animals to disease (Pankhurst, 1996). Nevertheless, in spite of the difficulties smallholder dairy intensification has generally provided substantial income increases to smallholders in the Ethiopian Highlands (Shapiro and Buta, 1997; Gryseels, 1988).

Milk yield per day, lactation length, and calving interval are three productivity parameters basically influencing smallholder benefits. Table 3.3.5 summarizes on-station results of the parameters for indigenous and crossbred cows found in the Ethiopian Highlands. The differences of these parameters between local cows and crossbred cows are substantial. Besides their low genetic potential for high milk yields, the second most important constraint in the productivity of indigenous cows is severely limited grazing in the dry season, which leads to substantial weight loss during that time. Indigenous animals are therefore not expected to produce more than 400-600 l average milk yield per lactation period with a daily milk yield of about 2 l on-farm. When crossbred cows and the complementary forage component are incorporated into the production system, farmers have achieved up to 2000 l milk per cow per lactation and an average daily milk yield of up to 6 l in the smallholder environment around Debre Zeit (Gryseels et al., 1984).

Table 3.3.5 On-Station production parameters of indigenous and crossbred cows

	Animal Breed			
	Arsi • Jersey	Arsi	Zebu	Zebu • Friesian
Calving interval (months)	14,5	14,6	15,0	15,0
Lactation length (days)	334	272	303	378
Milk yield (liters/cow/day)	5,2	2,7	2,8	6,3

Source: Hurrissa et al. 1993 (modified).

3.3.4.1 Household Income and Consumption Benefits

Substantial increases in income have been reported for smallholder households shifting to intensified dairy production at various sites in the Ethiopian highlands. For households around Debre Berhan incomes more than doubled due to the incremental income attained through the higher profitability of crossbred cows. In the Holetta region farmers using crossbred cows were found to have almost 70 percent higher cash incomes and an almost 50 percent higher income increment (gross margin) overall (Wagenaar-Brouwer, 1986; Gryseels et al., 1984; Shapiro and Buta, 1997).

In the Debre Berhan area a study was conducted to analyze household nutrition effects of intensified dairy production. Resource allocation, food intake, and nutrition indicators were compared between households owning crossbred cows and those owning indigenous cows. For adopting households average per caput daily energy intake was slightly lower, but calories provided by livestock products in the diet were double. In accordance with this results per capita milk consumption was likewise twice as high among adopting households (Gryseels et al., 1984). There was no analysis of micronutrient intake and growth monitoring of pre-school children did not control for age.

In another study in the Selale region (Wagenaar-Brouwer, 1986), while controlling for differences in farm size, per capita food availability (expressed in monetary terms) was estimated to be almost double for crossbred cow adopting households than for non-adopting households, 1 029 birr as opposed to 689 birr, respectively. Some increase in *kebe* and milk consumption has been observed, but unlike the effect in the above cited study, most of the increase in food availability for consumption was cereals. However, it is important to note that food availability does not necessarily coincide with food intake. Food expenditure surveys (measuring food availability) in rural areas typically provide over-estimates of the actual food consumption increases (Bouis et al., 1992; Bouis and Haddad, 1991). Nevertheless evidence in summary suggests that per capita food consumption is most probably increased as a result of intensified dairy production.

3.3.4.2 Reallocation of Labour

Described in the previous section, the introduction of crossbred cows certainly inherits immediate advantages to adopting households, such as increased milk yields and increased cash incomes. Nevertheless, the introduction of cross-bred cows likewise radically alters the production and management dynamics at the household level and this for several reasons. There is the need for separate management of the valuable animals from the rest of the herd, in order to avoid insemination and prevent infections and communicable diseases. The cows have to be housed separately and fed separately. This foremost involves the allocation

of labour. A study conducted in the early 1980s indicated that there is particularly increased labour demand placed on women. Since the animals are stall fed, they stay close to the homestead, requiring additional care by the women (Gryseels and Whalen. 1994). Later studies (MoA and FINNIDA, 1992) confirmed that women's labour time was increased, nevertheless the overall labour time of men increased the most.

In his sociological studies, Pankhurst (1993 and 1996) supports this findings, explaining that according to the customary division of labour in the management of livestock, men plough, boys herd, while women and girls milk and make butter and cheese, tend to clean the barns, and process the dung. "It is not that there is any strong taboo against men milking; it is just that it is not the done thing" (Pankhurst, 1996, 46). Likewise though there does not seem to be a strong taboo against men cleaning barns it is considered women's work. However, with the introduction of cross-bred animals it is possible that this could change as men who are generally household heads, are likely to take more interest in the valuable cross-bred cattle. In terms of assignments of labour there are two options available to farmers: To use family labour or to employ labour. The decision whether to add to the already high burden of labour placed on household members, or whether to employ additional labour, a herd boy or a maid, does not only depend on financial considerations. Families were also found to be reluctant to trust their valuable animals over in the hands of strangers (Pankhurst, 1993).

3.3.4.3 Commercialization of Dairy Production

The amount of milk indigenous animals supply a household with are so small that it often renders marketing of fresh milk or dairy products impossible. Prior to the introduction of crossbred cows the sale of dairy products did not contribute significantly to the household economy. Milk was generally not sold and the sale of *kebe* or *ayib* was occasional and/or seasonal (Pankhurst, 1993).

For the Holetta region Pankhurst (1996) discovered that there had already taken place an evolution in dairy commercialization over the recent past. Traditionally, in Oromo society there were strong norms against the commercialization of any livestock products. It is said that still in the 1960ties it could be observed in local markets in the Arsi region that women exchanged butter for barley and than sold the barley for cash in order to get round the prohibition in a culturally acceptable fashion. Although most farmers in Pankhurst's study have denied any cultural reasons for not selling livestock products, there were a few noteworthy exemptions. Most of the exemptions revolve around the belief that certain rituals, specific to the Oromo culture, have to be observed in order to avoid misfortune in the type of illness to the cow or calve. It is also interesting to note that livestock products are not sold

immediately after the beginning of the lactation, because the products at the initial stage are culturally expected to be consumed at home. This shows that since the sale of livestock products was not allowed in Oromo culture, it is a fairly recent phenomenon.

Milking and the processing, use and sale of dairy products has traditionally been the domain of women and they have a high degree of control over the income from the sale of the dairy products (Gryseels and Whalen, 1984). Until the introduction of crossbred cows milk was mainly used for home consumption and was not sold except by very few farmers living in more urbanized areas close to the towns of Addis Alem and Holetta. In rare cases milk was sold to the DDE. The sale of *kebe* and *ayib*, nevertheless, was commonplace. When husbands were asked about this activity of their wives they were well aware of it, but they did not know the amount of cash income their wives obtain from the sale of *kebe* or *ayib*. They commonly remarked that this was the affair of women, suggesting that the women use the income to buy things such as coffee, salt, and spices (Pankhurst, 1993). It seems likely that with the adoption of crossbred cows men will become more concerned with controlling the income from the milk of these animals. Pankhurst concludes: ”This is predictable, given the greater investment of capital for buying the crossbred cows, constructing their barns, buying feed and concentrates, the costs of hiring labour, and the labour for growing fodder crops, and because of the potentially greater income to be derived from the sale of milk” (Pankhurst, 1993, 47).

4 Analytical Approach and Methodology

In this chapter the model applied to investigate nutrition effects of smallholder dairy intensification and commercialization is presented. This is followed by a description of data sources and related survey undertakings. In the second part specific methodological issues are discussed. The concepts behind household income, expenditure and consumption measures are explained, the use of anthropometry scrutinized, and details about the survey implemented by the author presented. Finally modes of data analysis are documented.

4.1 Analytical Approach

4.1.1 Theoretical Underpinnings: The Household-Farm Model

Expressed more detailed in chapter 1.2, the objective of this study is to investigate the effects of intensified dairy production on smallholder welfare, the particular indicator being child nutrition. How do the implications of changes in dairy production and increased income eventually impact on child nutrition? The proximate determinants of child nutrition are decisions made by households in response to the new technology. A comprehensive theoretical framework for analysis of agricultural change and child nutrition has been presented in chapter 2.3.1, additionally a modified framework, developed to illustrate the relationships under investigation in this specific study case has been presented in chapter 1.3.1. Both frameworks have at their basis the underpinnings of the household-farm model which shall briefly be delineated on at this point, since it builds the very foundation of the analytical approach.

The household-farm model has been extended by Behrman and Deolalikar (1988) to include health and nutrition outcomes in a household's utility function. The model explains the farm household's economic reality as such: A farm household has a fixed amount of time and capital that it must allocated among various income-generating activities, given exogenous prices for consumption goods, production inputs and outputs, with the objective of maximizing the well-being of all household members from consumption expenditures, leisure time, and better nutrition. Depending on how available resources are allocated to own-farm production activities and off-farm employment, a certain amount of cash and in-kind income is generated that can then be spend on various investment or consumption items (Kennedy and Bouis, 1993).

An ongoing discussion is taking place on whether the "unitary" model with its joint utility function should preferably be replaced by a "collective" model (Folbre, 1986; Senauer, Garcia and Jacinto, 1988; IFPRI, 1992; Alderman et at., 1995). Under the conjecture of a

joint utility function a household's income is conventionally considered pooled income and preferences are assumed to be the same for all household members. On the contrary, "collective" models partly allow for bargaining situations. Behrman and Deolalikar (1988, 642) argue, that this "has no different implications for empirical specification since the same structural and reduced-form relations for health and nutrition result", although the interpretation of some variables may differ to the extent that they reflect bargaining power of different household members instead of the actual productivity of their human capital. For this study purpose, it is of particular interest, that bargaining strength can be emanating from income controlled by an individual, e.g. the household head. Nevertheless, a "unitary" model with its joint utility function is not "silent on the issue of intrahousehold distribution" (Haddad, Hoddinott, and Alderman, 1997, 1), therefore its use is not put into question within the context of this study.

An aspect of more immediate significance is the circumstance that the conventional application of the household-farm model would necessarily treat all household allocation decisions on what is produced and what is consumed as simultaneous (Behrman and Deolalikar, 1988). Econometrically this leads to a set of reduced-form demand functions with endogenous outcomes as dependent variables and exogenous determinants as explanatory variables with the unfortunate consequence that the empirical analysis does not any longer provide the desired information on structural coefficients (Bouis and Haddad, 1990). Using the conventional procedure it is for example possible to estimate the net effect of a change in prices on child nutrition, but it does not usually provide much information about the structural coefficients, such as decline in use of health services or decline in food consumption, which are so important in order to explain the process through which nutrition is affected by changes in the production system. Neither would it be possible to identify key factors that drive that process. Therefore a number of studies[11] refrain from building the analysis on an integrated household model, but in stead rather conceptualize a set of problems in terms of partial analyses based on the framework presented in chapter 2.3.1 (Braun, Puetz and Webb, 1989). The assumption of simultaneous decisions in the household production and consumption system is released to the extent that a system of recursive estimation equations is specified[12], which permits the analysis of cross-sectional data (Bouis and Haddad, 1990).

[11] IFPRI Research Reports No. 63, No. 73, No. 75, No. 79, No. 100, to give a few examples. They all are cited at other occasions in the text and listed as references.
[12] This demands careful testing for simultaneity bias and if necessary application of instrumental variables (Gujarati, 1988).

4.1.2 Empirical Design

The above explained approach of analysis had been envisaged to be applied in this study, but unfortunately it could not be carried out. A study of this limited scope could not adequately handle the encountered difficulties inherent in such capacious approach to analysis. Furthermore, limited data quality prevented to draw conclusions from a regression estimation. Nevertheless, the original setup of a system of recursive equations is illustrated Table 4.1.1 because it assists a better understanding of the anticipated changes taking place within the households using technologies for intensified dairy productions.

Table 4.1.1 The original recursive model and variables

PER CAPITA FOOD EXPENDITURE= f(	MOTHER'S INCOME SHARE INCOME FROM DAIRY SALES OTHER HOUSEHOLD INCOME FATHER'S EDUCATION MOTHER'S NUTRITIONAL KNOWLEDGE FATHER'S AGE)
PER CAPITA CALORIE CONSUMPTION= f(	*PER CAPITA FOOD EXPENDITURE* CULTIVATED LAND FATHER'S EDUCATION MOTHER'S NUTRITIONAL KNOWLEDGE FATHER'S AGE)
Z-SCORES OF CHILD NUTRITION= f(	*PER CAPITA CALORIE CONSUMPTION* MILK CONSUMPTION MORBIDITY WATER SOURCE MOTHERS NUTRITIONAL KNOWLEDGE WEANING AGE PEROGATIVE GIVEN AT BIRTH MOTHER'S HEIGHT MOTHER'S AGE CHILD'S SEX)

The identified variables remain the study focus, even if the actual analysis is not a regression analysis but a comparative analysis intending to identify significant differences between the endogenous variables of the two groups of households - adopters and non-adopters - under investigation. The comparative analysis is preceded by a factorial analysis. The proceedings are further explained in section 4.3.

4.1.3 Survey Design and Data Collection

4.1.3.1 Data Components

The larger fraction of data utilized for the current study is obtained from a comprehensive survey, which is part of an impact assessment of the PUDT-Project conducted by ILRI in collaboration with IAR (Ethiopian Institute for Agricultural Research) and EHNRI (Ethiopian Health and Nutrition Research Institute). A formal socioeconomic survey conducted by ILRI/IAR yields household-level data on production, income, expenditure, and marketing of food crops, feed, livestock and livestock products to assess intra-household effects of intensified dairy production in the Ethiopian Highlands. EHNRI collected household-level data on food consumption and individual-level data on health and nutrition of children to assess project effects on child nutrition.

At the original outset of this study it was planned to collect additional data using a somewhat complementary methodology to the formal quantitative appraisals of ILRI/IAR and EHNRI. The objective was to learn about the farming environment in a more holistic context. To do this, qualitative data collection techniques were envisaged to be used, because they have been particularly advocated in the context of intra-household analysis (v Braun and Puetz, 1993; Sim Feldstein and Jiggins, 1994; Gittelsohn and Mookherji, 1995). The motivation behind this advocacy of qualitative data collection techniques can partly be seen as finding means to economize with generally scarce recourses available at most research institutions, but it is likewise hoped to achieve better accuracy in combining quantitative and qualitative methods. Unfortunately a number of reasons made it impracticable to follow the original outset. Only an informal survey, very limited in scope, was carried out.

One important data gap remained within the ILRI/AIR and EHNRI data collected in their survey. Child care, health and sanitation related information, important aspects of child nutrition, was lacking. Above this, the questionnaire on maternal nutritional knowledge carried out by EHNRI had serious methodological flaws. Therefore an improved questionnaire, still based on the EHNRI questionnaire was designed by the author, which incorporated additional questions concerning the required information on child care and sanitation. Development and implementation of this questionnaire is further explained in section 4.2.3 and documented in the Appendix.

Table 4.1.2 gives an overview of the various data components utilized for analysis. The formal survey carried out by ILRI/IAR in collaboration with EHNRI, particularly the parts incorporated in this study, can generally be referred to as collecting consumption and expenditure data for a thorough micro-level socioeconomic investigation to which is added a

component on child nutrition. In the following section 4.2.1 details of the consumption and expenditure survey proceedings as well as methods and techniques applied will be discussed. In section 4.2.2 methodology and techniques used by EHNRI to assess the nutritional status of children is explained. The additional questionnaire, which is directed at the wives of the farm households and has been designed and implemented by initiative of the author, is described in section 4.2.3.

Table 4.1.2 Components of the analysis and available data elements:

Component of the analysis	Institution	Available Data Elements
Income	ILRI	Income Sources Control over Income by Wife and Husband
Expenditure	ILRI	Farm Inputs Non-Food-Expenditure Food-Expenditure
Household Food Consumption	EHNRI	Quantities of food consumed, Nutrients consumed, Diet Diversity
Individual Milk Consumption	ILRI	Amount of Milk consumed by Children, Men, Women
Care Factors: Education Nutritional Knowledge Feeding Practices Food Consumption Habits and Believes Health and Medical Service claimed	Questionnaire implemented by the author	 Formal School Attendance Score on Nutritional Knowledge Infant Feeding Practices Believes and Habits related to Food Consumption Occurrence of Illness and Use of Medical Services
Water and Sanitation Situation	Questionnaire implemented by the author	Availability of Clean Water and Sanitation Facilities
Nutrition	EHNRI	Nutritional Status of Children

Compiled by the author.

4.1.3.2 Household Survey Sample

The study includes 80 households. These households are a sub-sample taken from the total of 125 households participating in the PUDT-Project, which is still under on-going survey by ILRI/IAR. At the beginning of the project in 1993 with only 14 farmers participating at first, a survey was carried out to collect mainly farm production data. In 1995/1996 additional 51 farmers obtained upgraded cows from IAR and agreed to participate in the PUDT-Project. Whereas the initial farmers were relatively rich, with large landholdings, large herd size and surplus of manpower, the additional 51 farmers were chosen to be more representative according to the local standard of resource endowments (Larsen, 1997). Moreover, another group of 60 farmers was selected to serve as a control group. They own indigenous cows and use traditional farming practices. While the project farmers agreed to be surveyed, which was part of their contract to participate in the PUDT-Project, the control farmers were asked to take part in the survey although they would not receive any benefit from it. Table 4.1.3 gives account of the number of households participating in the survey categorized by their respective resource endowment.

Table 4.1.3 Categories of survey-farmers:

Categories of farmers	Number	Resource endowment/Characteristics
Resource poor farmers	17	0-1 oxen, less than 5 animals., 1,5 ha under plough, limited labor
Medium income farmers	17	pair of oxen, less than 10 animals, 2,5-3,0 ha under plough, family labor
Resource rich farmers	31	minimum two pair of oxen, more than 10 animals, above 3 ha under plough (rent additional land), additional income from off-farm activities
Control farmers	60	Selected at random in the area where the project is conducted. Except from participation in training and discussion sessions these farmers are following traditional farming practices without crossbred cows.

Source: Larsen (1997), modified.

The size of the sub sample, including 80 households, results from the fact that only households with children of a certain age group were suitable to take part in an impact assessment which monitors nutritional effects. Every household with one or more children between half a year to 7 years of age was included in the sub sample. By coincidence it appeared that within the 80 households exactly half (40) are project farmers, the other half are control farmers. Out of all children in the sub sample one child per household in the age group of 6 to 72 months (1/2 to 7 years) was selected by EHNRI to be monitored as a so called 'index-child'. These 80 'index-

children' form the group of children for the survey of nutritional outcomes of individual household members.

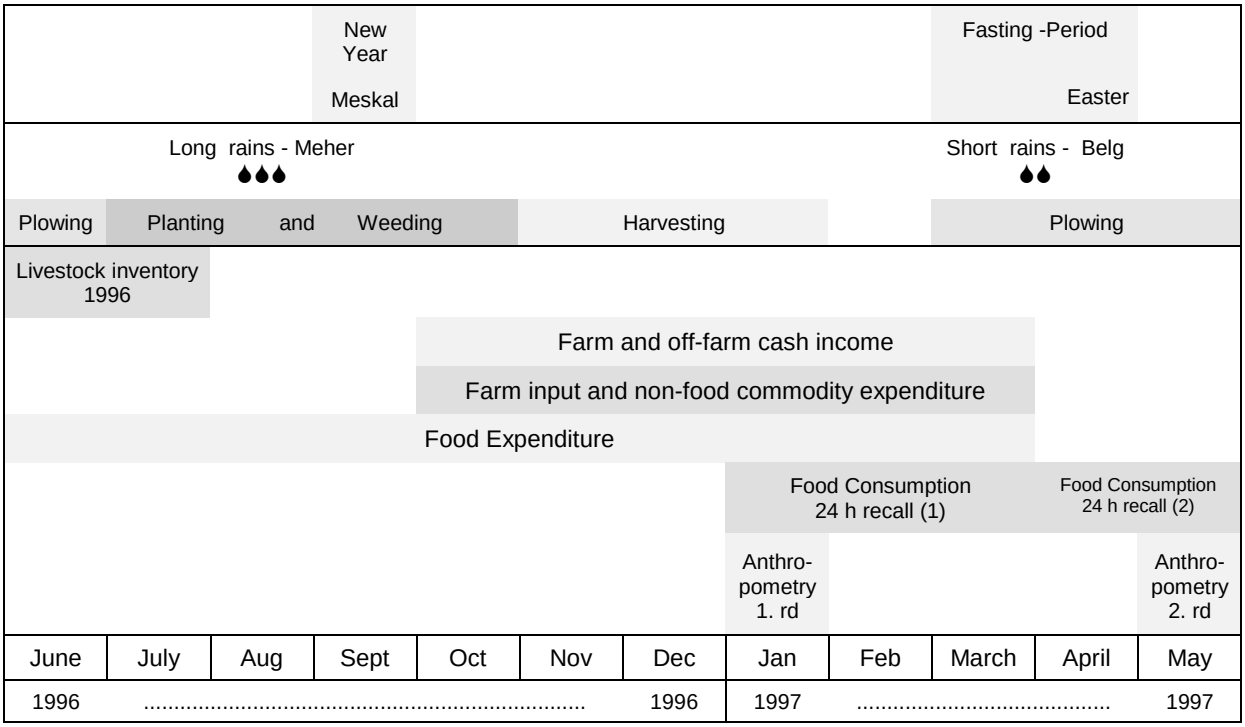
4.1.3.3 Data Collection Activity's Timetable

In October 1996 ILRI/IAR started to collect on-farm data on socioeconomic variables. About 30 specially trained enumerators collect these data in addition to the farm production data, which is already collected since 1993. The enumerators reside in the project area, many of them since the beginning of the project in 1993. They visit the households once a day all year round. Land and animal inventories in addition to grain records are taken once a year during and after the harvest. The questionnaire on maternal nutritional knowledge, additionally comprising an inquiry on sanitation and health, has been carried out from May to July 1997 with the assistance of an externally hired translator as well as technical staff and enumerators from ILRI/AIR.

EHNRI started to collect data on the nutrition related part of the survey in January 1997. A baseline survey consists of anthropometric measurements of all children and adults of the households, clinical assessments on health and nutrition of children and a questionnaire directed at mothers of the so called 'index children'. Continued quarterly rounds of data collection only include the 'index children'. They are follow-ups on changes in anthropometry, as well as clinical eye examinations. Beginning in 1997 household food consumption surveys are carried out by two specially trained enumerators. Again, each household is visited once in three months.

Apparent from the above brief description of the joint efforts by three institutions employing more then 30 enumerators, a large volume and diversity of data is collected, which facilitates comprehensive in-depth studies on various farm production and consumption related issues. In order to avoid misunderstandings or disappointment about expected study results, it is important to point out that the scope of the present study is limited. Moreover, not all survey components were available, furthermore, no year round data files were completed at the time the data analysis took place. Particularly in subsistence and semi-subsistence agriculture, production as well as household consumption are dependent upon the prevailing season. Any assessment concerned about nutritional outcomes therefore needs to carefully record seasonal changes. Unfortunately even the most comprehensive data file, that on food expenditure, covers only a period of 10 months. Files on income and non-food expenditure cover six months. The six months period begins with the onset of the 'lean season' (the rainy season) and ends after the harvest. Table 4.1.4 illustrates further details on the concurrence of agricultural activities, seasons, Ethiopian holidays and data collection intervals.

Table 4.1.4 Agricultural activities, seasons, Ethiopian holidays and data collection intervals



Compiled by the author.

4.2 Methodological Issues

4.2.1 Household Income, Expenditure and Consumption Data

Household income, expenditure, and consumption data utilized for the empirical analysis has been exclusively obtained from the ILRI/AIR and EHNRI survey on welfare effects of the PUDT-Project conducted under their mandate. At this point the terminology *consumption*, *expenditure* and *income* shall be explained, because it is likely to create confusion. The pairs of terms *income and expenditure* and *consumption and expenditure* are under certain circumstances used interchangeably and therefore need to be closer defined.

For the majority of socio-economic studies where a measure of household income is required, it is very common to use *total household expenditure* as a proxy *for total household income* (Bouis and Haddad, 1991; Bouis at al., 1992). Compared to measures of total income, total expenditure is considered a more reliable indicator of a household's long term well-being primarily for two reasons. One reason is that total expenditure is less variable than income, especially in rural areas where agricultural production and non-farm employment opportunities are highly seasonal, because total expenditure is less affected by fluctuations in short-run income, which can be smoothed out by saving, dissaving, and borrowing. Secondly, expenditure data is easier to collect, because households are generally expected to more freely declare their expenditures than their income. For example, a wealthier household may underreport income in fear of higher taxes, which leads to underestimates, while a poorer household may over-declare income out of pride (Levin, 1991).

Similarly, the terms *total household consumption* and *total household expenditure* are often used interchangeably to explain a household's level of resource use for various types of studies. In the broadest definition of the term, household consumption refers to all goods and services consumed by the household. Total consumption is then measured as total expenditures on food and nonfood goods and services. Presented in this way, total consumption can be interpreted as either the quantities of goods and services used up in final consumption, or as the total value of money, time, and assets spent on those goods and services - the expenditures. This makes it possible to use both terms synonymous (Levin, 1991).

In the present study, expenditure refers to cash expenditure on food and non-food commodities and services. Income refers to cash income obtained from any kind of market involvement. Consumption refers to the nutritional definition of actual household food intake, which is measured by quantities of food ingested by household members. Data on income and expenditure refers to cash income and cash expenditure. No data on total household income or total household expenditure, which includes calculations about the build up or utilization of stocks for subsistence purposes, has been assessed by the ILRI/IAR survey. This necessitates to make an underlying assumption for the current study, namely that differences in the availability of farm resources do not determine cash expenditures.

4.2.1.1 Household Income and Expenditure Data

The survey technique applied by ILRI/AIR to gather information about type, amount and person responsible for income and expenditure is the *list recall method*. This is a direct, quantitative method commonly put into practice to collect household data (Levin,1991). Enumerators use structured questionnaires that contain an explicit list of all major food and non-food items traded and consumed in the region, also called fixed questionnaire formats. They visit the farmers on a daily basis and ask one of the senior household members, usually wife or husband, to answer the predefined questions about all possible cash transfers, which took place the previous day. Quantity, price, and value of all items sold or purchased by the household are recorded. The recording additionally indicates whether transfers had been undertaken by wife or by husband. Likewise information was gathered on milk production, distribution and consumption. This method of data collection is considered a very accurate technique, because it is not difficult to remember cash transfers over the limited period of 24 hours. The disadvantage is that one might be confronted with respondent fatigue (Levin, 1991), especially when the survey lasts over a couple of months or even years, as it is the case here. Table 4.2.1 gives an overview over all questionnaire formats utilized for this study, their respective contents and data components obtained from the survey.

Table 4.2.1 Overview over ILRI/IAR questionnaire formats utilized for this study component:

Data Source	Components	Measurements
Form 3	Expenditure on input for forage and cash crop production	item type, amount, expenditure by wife and husband, total
Form 4	Expenditure on food for consumption	item type, amount, expenditure by wife and husband, total
Form 5	Expenditure on animal feed	item type, amount, expenditure by wife and husband, total
Form 6	Income from sale of livestock, livestock products other than dairy	type of product, amount, income by wife and husband, total
Form 7	Expenditure on livestock products other than dairy, meat and eggs	type of product, amount, expenditure by wife and husband/total
Form 8	Expenditure on livestock and livestock products	type of product, amount, expenditure by wife and husband, total
Form 9	Income from sale of food crops	crop type, amount, income by wife and husband, total
Form 10	Income from sale of feed crops	type, amount, income received by wife/husband/total
Form 11i	Off-farm income	type, amount, income received by wife/husband/total
Form 11e	Off-farm expenditure	item type, amount, expenditure by wife and husband, total
Form 12	Milk production and distribution	no. of cows , animal breed, milk yield at morning and evening, distribution to calve/children/men/women
Form 14	Income from sale of dairy products	dairy product type, location of sale, individual who sold, amount, price received
Form 15	Expenditure on animal health and other services	service type, expenditure by wife and husband, total

Compiled by the author.

4.2.1.2 Food Consumption Data

The purpose of a survey on household food consumption is to assess, as accurate as possible, the amounts and types of food actually ingested by individual household members or the household as a whole (Gibson, 1992). The focus can for example be an inquiry on energy availability or protein content of foods consumed, it can also cover a range of different nutrients under study. The particular objective for the present study case has been to compute, from the available data average per capita food consumption for households

adopting dairy intensification technologies and for households using traditional practices. Food consumption is expressed in calorie-, protein-, fat-, carbohydrate-, iron-, beta carotene-, and retinal-content of the foods consumed. Beta carotene and retinal are precursors of vitamin A, the main focus in the assessment of micronutrient consumption of this study.

Household food intake was measured using the *24-hour food recall method.* In this type of survey, the enumerator interviews the household member responsible for meal preparation, usually the household wife, on the food consumed by all household members in the past 24 hours(Low, 1991). Each meal is described, including the names of all dishes prepared. Separately all raw ingredients used in each recipe are recorded. Quantities of foods consumed are measured by taking their weights. The enumerator asks the wife to show her/him which containers she uses to measure amounts of ingredients and to repeat the procedure so that the ingredients can be put on a scale which the enumerator carries along. Weights and the number of people present at the respective meal are recorded. In the EHNRI survey, 24-hour food recall surveys were undertaken once in three months. Data used for the current study is from the second round 24-hour food recall undertaken in April 1997.

4.2.2 Anthropometry

4.2.2.1 Nutritional Assessments using Anthropometry

To assess the nutritional status of children, anthropometry is used. Anthropometry is the science of measuring the human body and its parts. In this case, it means that height (or length), weight, age and sex of children are recorded and put into relation to a reference standard. The degree of variation from the reference is used as an indicator to make statements about the state of nutrition of children.

Other approaches can be applied to make inferences on the nutritional situation of a population. It is for example common to use aggregate data on birth weight, child mortality or food balance sheets to identify the prevalence of malnutrition among children in a country or region (WHO, 1993). These are indirect measures. Other types of direct measures besides anthropometry are clinical, biochemical and dietary assessments (Gibson, 1990). Clinical assessment is the examination of physical signs on the body that are symptomatic of nutritional disorders. Biochemical assessment requires examination of body fluids such as blood or urine for metabolic changes. Dietary assessment is the measurement of food intake (Gibson, 1990).

Anthropometry is the most widely used tool in direct nutritional assessment, especially for assessing nutritional status in societies with significant levels of protein-energy malnutrition

(PEM). Anthropometry is thought to be least invasive. A particular advantage is, that it can easily be used by relatively unskilled researchers or enumerators (Low, 1991).

4.2.2.2 Concerns about the Appropriateness of Anthropometric Measures for Nutritional Assessments

It is important to notice that indices derived from anthropometric measurements are only indicators. They serve as a proxy for the nutritional status of children. This indicator does not only reflect changes in energy and nutrient intake but it is also affected by non-nutritional factors, such as disease, genetics, and diurnal variation (Low, 1991). Two crucial issues arise in the context of non-nutritional factors. First, the appropriateness of an anthropometric indicator depends on the purpose it should fulfill. Food-security emergency situations, continues surveillance systems, surveys on local or regional scales, growth monitoring in clinics or collection for analytical purposes all imply that different anthropometric instruments should be considered. Secondly it is crucial to which extend non-nutritional factors affect the sensitivity of the indicator. Concern in this regard is directed toward the general comparability of the measurements taken (Low, 1991). This second aspect is further discussed below.

4.2.2.3 Comparability across Cultures

After taking anthropometric measures from children, e.g. Ethiopian children in this case, these measures are compared to values of the same age and sex group in a reference population. By international standard the reference population presently used is the so called 'NCHS' reference population, whereby 'NCHS' stands for the largest population census ever undertaken - in the United States (WHO, 1993). Relating to non-nutritional factors, a controversial issue is whether children from different areas of the world, across cultures can be compared to the standard population of American kids.

Regarding the argument that children do not have the same genetic potential for growth across cultures, it is stated, that for children 0-5 years, growth rates are the same and only begin to be influenced by genetic potential at puberty (Gibson, 1992). It is further argued that several studies indicate, that presumably well-nourished, upper-class children in developing countries grow at the same rate as upper-class children in developed countries. This implies that growth patterns are influenced more strongly by environmental factors such as dietary adequacy and frequency of illness than by genes (Low, 1991).

4.2.2.4 Measurements and Procedure

For the current study the aim is to estimate whether the nutritional status of the children from CBC households and children from LBC households deviate from the reference population and whether there is a difference in this deviation between the two groups of children. By

international standard the deviation from the reference population is to be expressed in standard deviations (WHO, 1993). Table 4.2.2 summarizes the categories of child growth performance with their respective standard deviations from the reference population.

Table 4.2.2 Deviations from the reference population and categories of growth performance

Deviation from reference population:	Category of growth performance:	Abbreviation:
above median to 1 SD	normal growth	A
between 1 and 2 SD below median	mild retardation	B
between 2 and 3 SD below median	moderate retardation	C
below median of 3 SD	severe retardation	D

SD: standard deviation

Source: WHO (1993)

Measurements:

Height or length (depending on the age of the child) and weight are measured. For each child sex and age in months is also recorded. The parameters which can be calculated are:

Height-for-age

An impairment to height(length) for age indicates chronic malnutrition. This indicator is also commonly called *stunting*. An expression that the child is shorter than one would typically expect for a child of the same age because of the accumulated effect of past bouts of morbidity and extended periods of inadequate food intake (WHO, 1993).

Weight-for-height

An impairment of weight for height (length) indicates acute malnutrition. This indicator is also commonly called *wasting*, expressing that the child is too thin for his or her stature because of a recent and severe food deficit or illness. This is also the only useful indicator if age of a child is unknown (WHO, 1993).

Weight for age

An impairment of weight for age indicates a combination of both, acute and chronic malnutrition, commonly called *underweight* (WHO, 1993).

To maintain accuracy and precision of anthropometric measurements, so that comparability is possible world wide, WHO has developed standardized procedures (WHO, 1993). The comparison of weight, height, sex and age measurements of a population to reference standard is facilitated by software programs. For the current study the software program

ANTHRO has been used. The standard deviations are commonly referred to as z-scores by nutritionists (Gibson, 1992).

4.2.3 The Questionnaire on Maternal Nutritional Knowledge, Child Care and Sanitation

To complete the study an inquiry on maternal nutritional knowledge, child care, and sanitation had been carried out in order to gather information on variables, known to have a considerable influence on child nutrition, although they are not immediately related to the dairy intensification and commercialization processes. The primary objective of the study is to assess the effects of intensified dairy production and commercialization on child nutrition, still all factors known to determine child nutrition have to be considered in the analysis, otherwise statistical results are biased and misinterpreted caused by missing variables (Behrman and Deolalikar, 1988). The list of variables potentially affecting child nutrition, however, can never be all inclusive (Pinstrup Andersen, Pelletier and Alderman, 1995). Nevertheless, some variables of particular importance for the specific situation and locality can be identified and have been scrutinized in chapters 2.3 and 3.3.

To acquire the desired data on maternal nutritional knowledge, child care and sanitation an adequate data collection methodology has to be applied. Generally the researcher has the alternative to either use qualitative data collection techniques, or to use a formal approach in the design of the inquiry. Whereas the former approach often has the advantage to generate new and even ‘surprising’ information, the latter approach has its advantage in the context of validation, especially facilitates quantification and allows results to be reproduced and compared (Poate and Daplyn, 1993).

As guideline for the choice of survey methodology Poate and Daplyn (1993, 3) state: ”A good design will match the characteristics of different approaches to the objectives and constraints of the survey.” In this particular case data of 80 survey households had to be collected in order to utilize it for the comparative analysis. Visiting 80 households in a very limited time is only possible with the help of enumerators. In regard to these requirements a structured questionnaire directed at the household wife, the mother of the surveyed ‘index’ children, was developed.

4.2.3.1 Questionnaire Contents

The questionnaire was primarily conducted with the aim to derive information on three important aspects of child care variables, which determine child nutrition in a particular social and cultural environment:

1. To rank mothers according to their knowledge about child nutrition, based on the accuracy of answers given to selected questions.
2. To provide information on infant and child feeding practices.
3. To provide information on hygiene and sanitation, and the accessibility of health care facilities.

Mothers were asked questions about different aspects of child care giving behaviors. The questions cover infant and child feeding practices, knowledge about the nutritional value of supplementary foods, believes concerning dietary needs during pregnancy, utilization of health services, awareness about the general health situation of children in the villages, and the quality of the water source of the family. The questionnaire format is presented in the Appendix.

A commonly used tool to find out about the level and variability of nutritional knowledge of mothers is to ask them questions about prevalent believes and actual habits related to child care, such as feeding practices and handling of the common diseases like fever or diarrhea. Questions are designed in a way, that scores can be given according to the relative quality of the answers in the given environment. These scores then indicate the nutritional knowledge of the individual mothers (Low, 1991). It is important to set a certain standard of accuracy, which actually can be attained by the respondent. In this particular context the standard was set to be the information given out to women living in rural areas by health workers who visit villages and give nutrition education[13].

The criteria on which the scores in this questionnaire are based are the answers to questions comprising 12 variables. They encompass participation in a health or nutrition programs, awareness of prevalent diseases children in the area suffer from, relative amount of food mothers need to eat during pregnancy, the first food given to newborn children, length of breastfeeding, initiation and quality of supplementary food, handling of diarrhea and foods believed to promote healthy and good development of children (Questions 1, 2, 4, 5, 6, 10, 11, 12, and 13 of the questionnaire).

Variables related to child and infant feeding practices covered by the questionnaire are

- duration of breastfeeding,
- age of introduction of first supplementary foods,
- foods or liquids traditionally given to infants at birth, and
- the quality of supplements given to the children.

[13] Contents of nutrition education, frequency of visits to the villages and the context in which these visits take place were obtained from interviews with health personnel at the local government clinic.

Variables related to hygiene and sanitation are

- existence of latrines,
- water source, and
- perception of the water quality.

These variables were identified as key indicators for the child nutrition situation in rural areas of Ethiopia (NNSS, 1992). This inquiry permits to compare the individual living conditions of dairy technology adopters and non-adopters. Furthermore, it facilitates to view evidence on these particular underlying determinants of child nutrition in the context of the general health and nutrition situation of the children of the survey households.

4.2.3.2 Questionnaire Development and Proceedings

The questionnaire had to be pre-tested four times until the final questionnaire format was established. Revisions were mainly necessary because previously unrecognized differences in the local understanding of certain terms regarding different foods consumed and the traditional believes connected to this. Cultural customs which would not have been regarded important to mention unless explicitly listed in the questionnaire were discovered in each pre-testing phase. A particular topic which could not efficiency be covered is the appraisal on the health situation of the households. Almost no illness has been recorded, although interrogation of the local health personnel lead to the conclusion that many health problems exist in the area. Therefore this questionnaire part is not included in the analysis. Filled-in questionnaires were returned by the enumerators and immediately checked for missing answers or possible inaccuracies. Before the final coding, a prerequisite to data entry, certain parts of the questionnaires had to be translated. After this was done, data was entered and processed using SPSS (Statistical Package for Social Sciences, version 1997). The data analysis which followed the procedures explained above are described in the following section.

4.3 Data Analysis

Data analysis is carried out to derive reliable statements concerning the study objectives expressed in chapter 1.2. Its core part is the comparison between households, who adopted crossbred cows and associated technologies of intensified dairy production (CBC) with control households who are dairy farmers using local animals and traditional practices (LBC). The comparison aims at providing facts and figures about the impact that dairying with CBC has on food consumption and child nutrition of participating households. To gain knowledge about the magnitude of the net impact on nutrition as well as to identify key factors which bring about the improvement, it is necessary to compare changes in income, in expenditure patterns, and food consumption resulting from intensified dairy production. In summary, the study involves an analysis with (CBC) and without (LBC) the intensified dairy production technologies.

According to Poat and Daplyn (1993) survey analysis generally involves the following four aspects in differing degrees:

- data exploration
- estimation of characteristics
- testing of hypothesis
- quantifying relationships

The first part of the analysis, the exploratory analysis is the link between error checking for data quality and analytical interpretation. It implies the use of descriptive statistics and shall be briefly explained, giving detailed information on the calculations of some vital variables, such as adult equivalents for consumption, food-intake parameters, or evaluation of diet quality. In this study the second part, the analytical interpretation, primarily comprises a comparative analysis, preceded by a factorial analysis.

4.3.1 Exploratory Analysis and Estimation of Characteristics

The whole analysis was computerized using SPSS (Statistical Package for Social Sciences, Version 1997), except for data entry which was done under dBASE, a data management software package that provides easy transfer into SPSS. To prepare the data for statistical analysis it has to be cleaned first. Here exploratory tools are applied, a large part of which involves to identify the points around which data are located and the spread or dispersion of the data in order to check for outliers. For the capricious amount of ILRI/IAR and EHNRI data, a number of data entry clerks and a supervising statistician, who likewise cleaned the data, accomplished that task.

Estimation of characteristics involves the calculation of variables from the sample data. For the present study case it is mainly the calculation of population means, ratios and proportions. The following section gives account on these calculations.

Income and Expenditure Variables

First, data elements on amount and types of income sources and expenditures were regrouped and the variables, which were used to analyze absolute amounts and structure of household income and expenditure, as documented in the results in chapter 5, calculated. To calculate average monthly cash income and expenditure for CBC and LBC households, aggregated six months data was divided by six and corrected for differences in household size by multiplying with respective coefficients of CBC and LBC households. Household size has been calculated using FAO/WHO adult equivalents depicted in Table 4.3.2.

Milk Consumption

In order to make predictions about the distribution of fresh milk among different household members individual data for milk consumed by men, women and children was utilized. Average milk consumption by men, women and children has been calculated for the group of technology adopters and non-adopters by dividing through the number of men, women and children present in each household. To calculate average household milk consumption, FAO/WHO adult equivalents as presented in Table 4.3.2 have been used.

Food Consumption

Food composition tables assembled by Agren and Gibson (1968) exist for Ethiopia. These food composition tables provide calorie, protein, fat, vitamin, and mineral content of all foods regularly eaten in Ethiopia. On the basis of these figures, amounts of various dishes consumed by the households were converted into the nutrients under investigation (calories, protein, fat, iron, retinal, beta carotene). To calculate per capita food intake FAO/WHO, again coefficients as depicted in Table 4.3.2 for converting household size into per capita food consumption equivalents were used.

To assert diet diversity, ingredients of all meals consumed were regrouped into principal diet components, such as vegetables, staples, meat, sugar and oil and dairy products. Per capita average calories derived from these diet components are computed for CBC and LBC households in order to detect possible differences.

Household size

In many studies household size might be sufficiently expressed by simply indicating the total number of all household members. In this study more precise estimates are computed. One is a standard labour unit. The other is the adult male equivalent for food consumption. The latter is of particular importance for further calculations in the assessment of food consumption and diet quality. In Table 4.3.1 and Table 4.3.2 coefficients for standard labour unit and standard household size are depicted.

Table 4.3.1 Coefficients for converting household labour into a standard labour unit.

Sax/age category	Condition	Labour Unit
< 8 or > 75	All	0
Children (8-14)	1	0.5
Children (8-14)	2	0.25
Adult male (15-65)	1	1.0
Adult male (15-65)	2	0.5
Old men (66-75)	1	0.5
Old men (66-75)	2	0.25
House wives (15-65)	2	0.5
House wives (66-75)	2	0.25
Adult females (15-65)	1	0.7
Adult females (15-65)	2	0.35
Old women (66-75)	1	0.35
Old women (66-75)	2	0.18

Notes: Condition 1 refers to 'full-time worker' and condition 2 refers to 'part-time worker'

Source: Bekele (1991)

Table 4.3.2 FAO/WHO coefficients for converting family size into standardized household size.

Age category (years)	Sex	
	Male	Both	Female
< 1		0.4	
1-3		0.6	
4-6		0.8	
7-9		0.9	
10-12	1.1		1.0
13-15	1.0		0.9
16-19	1.0		0.8
20-39	1.0		0.8
40-49	1.0		0.7
50-59	0.9		0.7
60-69	0.8		0.6
>= 70	0.7		0.5

Source: Bekele, 1991

Tropical Livestock Unit (TLU)

To have a meaningful estimate for comparison of average livestock holding between CBC and LBC households, respective animal inventories are converted into TLUs (Tropical Livestock Units) obtained from Gryseels (1988, 85) presented in Table 4.3.3.

Table 4.3.3 Conversion procedures for metabolic weight and TLU holding.

Livestock type	LW (kg)	$LW^{0.75}$	TLU
Oxen/bulls	275	67.53	1.10
Cows	200	53.18	0.80
Heifers	125	37.38	0.50
Immature males	150	42.86	0.60
Calves	50	18.80	0.20
Sheep	22	10.16	0.09
Goats	22	10.16	0.09
Horses/mules	200	53.18	0.80
Donkeys	90	29.22	0.36

Source: Gryseels, 1988.

4.3.2 Comparative Analysis

The purpose of a comparative analysis is to assess differences between sub-populations (Poate and Daplyn, 1993). In this study two sub-populations, households with crossbred cows (CBC) and without crossbred cows (LBC) are compared. To establish whether selected characteristics, in this case predominately variable means, differs between the two groups under investigation, a hypothesis is set up and a test statistic chosen.

The statistical procedure is to use the null hypothesis, H_0, to frame the situation where no (null) difference exists between the specified value of the estimate of one group (CBC) compared to that of the other group (LBC). The alternative hypothesis, H_1, expresses that one estimate is not equal to the stipulated value under the null hypothesis. ”Not equal” corresponds with two-sided, as the alternative hypothesis accepts a value either greater or less than the stipulated value. Consequently a two-tailed test statistic is applied to compare the two means. If it is significant, the H_0 is rejected in favor of H_1 that the means are different. The statistical test indicates the probability for rejecting the hypothesis (Gujarati, 1988). Probability and with it level of significance are documented with the results in chapter 5.

For the majority of the analysis the use the t-test of significance is appropriate. A special case is the comparison of the average nutritional status of children expressed in z-scores. These are ordinal variables grouped in discrete categories. For analysis they have to be put into a contingency table, also known as cross-tabulation. In order to test for the relationship the Chi-square test is applied. This test examines the probability that the number of observations in each cell of the table would occur by chance. Again the significance level is presented with the results.

4.3.3 Factorial Analysis

Factorial analysis is a multivariate methodology applied to such data analysis which involves a high number of variables. The purpose is to reduce the large number of variables to a smaller number of so called factors, which still account for most of the variability of all variables and therefore sufficiently explain the model (Backhaus at al., 1993). Variables which are related to each other are bundled and can be replaced by their respective factors.

The current analysis involves a high number of estimates potentially important in their explanatory value, because various household income sources and expenditures on a variety of consumption commodities were assumed to matter in their effects on food consumption and nutrition. These income and expenditure estimates are separately

recorded for the responsible person - husband or wife. Therefore a factorial analysis was run in order to reduce the high number of variables. Furthermore, factorial analysis likewise facilitates the detection of structural relationships (Backhaus et al., 1994). The factorial analysis was run for both groups, CBC households and LBC households, separately.

Theory and practical application of factorial analysis is explained in Backhaus et al., (1994). The general procedure is explained here, while at the same time informing about the actual study case:

- At the basis a correlation matrix of the original data including all variables is computed. Variables are standardized by transposing means to zero and standard deviation to one. In this study the correlation matrix comprises 27 vaiables.

- In the subsequent principal components analysis the principal components with their respective eigenvalues are computed. At this stage the number of variables is still identical with the number of factors and 100 percent of the variability are explained by all factors. Eigenvalues reflect the percent of variance of the data.

- The next step is to reduce the number of factors. The Kaiser-Criteria can be applied. Than only factors with an eigenvalue equal to or greater than one are extracted. The alternative is to extract a number of factors in accordance with the explanatory power they exhibit for the whole model, expressed in percentage of variability. For the current analysis 10 out of 28 factors have been extracted. Together they account for 82,1 percent (CBC) and 83,7 percent (LBC) of the variability in the original data.

- A factor loading matrix is computerized for the extracted factors and rotated with the varimax rotation. The outcome is a matrix with all variables assigned to the factors, stating the relationships in the correlation coefficients. Correlation above 0,707 (Backhaus et al., 1993) are commended to take as a criteria when sorting variables. The result is a number of factors describing a bundle of variables and representing to the degree of their correlation an identical vector in a three dimensional space .

The survey data of this study exhibits high variability and not all variables are normally distributed. Furthermore, consumption and nutrition appraisals always create a lot of ‘random noise’ (Bouis and Haddad, 1990). Therefore the results of the factorial analysis rather serve the purpose to investigate whether fundamental structural differences exist between the two households groups under study. Since the factorial analysis is considered an exploratory tool

(Backhaus, et al., 1993) its results are briefly reported at this point (not in the next chapter). therefore not further discussed.

Table 4.3.4 presents the variables belonging to factors which explain 80 percent of the data variability. The factorial analysis does not contain any information, which is not explained in the next chapter and therefore not further discussed.

Table 4.3.4 Factors extracted in the factor analysis

Factor	CBC households	LBC households
1	per capita dairy income (birr) household milk production (liters) child milk consumption (liters)	per capita dairy income (birr) household milk production (liters) child milk consumption (liters)
2	per capita farm income (birr) livestock inventory (TLU)	per capita farm income (birr) per capita food expenditure (birr) per capita household income (birr)
3	per capita off-farm income (birr) calorie consumption (cal/adult equiv.) protein consumption (g/adult equiv.)	calorie consumption (cal/adult equiv.) protein consumption (g/adult equiv.)
4	per capita household income (birr) per capita livestock income (birr)	per capita livestock income (birr) livestock expenditure (birr) wife's expenditure (birr)
5	per capita off-farm income (birr) retinal consumption (ug/adult equiv.) fat consumption (g/adult equiv.)	per capita off-farm income (birr)
6	expenditure on livestock inputs (birr)	livestock inventory (TLU)
7	education of wife (years in school)	retinal consumption (ug/adult equiv.)

5 Results and Discussion

The results presented here compare 40 farming households who adopted cross bred cows and associated technologies for intensified dairy production (referred to as CBC) with 40 control households who are dairy farmers using local animals and traditional practices (referred to as LBC). The PUDT-Project and its farmers and their farming environment has already been described in section 3.3.3.2. and section 3.3.1. The farmers included in the present study resemble a sub-sample of 80 farmers of the original 120 survey farmers of the PUDT-Project. It shall therefore at this point only briefly be repeated that the study side is located about 70 km west of Addis Ababa in the vicinity of two small towns: Holetta and Addis Alem. The area belongs to the high potential cereal-livestock production zone of the Ethiopian Highlands. The farmers living in this region are periurban producers in the sense that they are living in close proximity to several towns. It has been shown that in particular the development of two towns in the area and the proximity to the capital, which has been expanding rapidly, has provided markets for the local farmers and influenced their production strategies (Pankhurst, 1996).

5.1 Characteristics and Environment of Survey Households

5.1.1 Household and Farm Characteristics

The survey farmers belong to nine different PAs (Sademo, Rob Gebeya, Telcho, Cherri, Jerba Sefer, Sororo, Markos, Wolmera, Dobbi), which are located in two *Awrajas*: Dendi and Wolmera. Indicated in Table 5.1.1, the average land area cultivated by all households comprises about 2,5 ha and livestock holdings are equivalent to 8,1 TLUs[14]. Main crops grown are teff, barley, wheat, and various types of pulses. The average area allocated to crop production is about 2,2 ha for all farmers, but variation in landsize among all farmers is substantial. CBC farmers have larger landholdings of 2,8 ha compared to 2,1 ha for control farmers, which is a significant difference at the 0,1 percent level. It is important to note, that CBC farmers have to allocate 0,5 ha of their cultivated land to fodder production as part of the contract with ILRI/IAR. It is therefore not surprising that the remaining crop area does not differ substantially between the two groups. Table 5.1.1 also documents that CBC farmers keep less livestock per ha. In fact, they should keep fewer, although more productive animals (the crossbred cows), as a consequence of their contract (further explained in section 3.4.1.3), in which they agreed to sell unproductive animals. TLU/ha for adopters is 3,1, for non-adopters it is 3,5. This difference is not significant, indicating the wide variation in livestock holdings. The average animal herd consists of about 2 cows, 2 oxen, a horse or

[14] Tropical livestock unit, taking an animal of 250kg liveweight as the basis for conversion factors for different sizes and species (G. Gryseels, 1988). Calculations are depicted in section 4.3.1.

a donkey, and a number of sheep and chicken. While the control farmers (LBC) exclusively own indigenous cows, the group of technology adopters (CBC) own indigenous and crossbred cows.

Table 5.1.1 Farm characteristics by technology group

	Total land cultivated (ha)	Crop land (ha)	Livestock holding (TLU)	Livestock holding per total farm land (TLU/ha)	Animal type owned (cattle)
CBC	2,8 + (1,3)	2,3 (1,2)	8,3 (4,4)	3,1 (1,6)	crossbred and indigenous zebu type
LBC	2,1 (0,7)	2,1 (0,6)	8,1 (4,8)	3,5 (1,7)	indigenous zebu type

Notes: Number in parenthesis are standard deviations
+) Difference between CBC and LBC: Significant at the 0.1 level

Source: Compiled by the author with survey data.

Households in this area of Ethiopia comprise a family unit of husband, wife and children. Often they live together with other relatives and accommodate a farm employee who often is related to the family as well. Indicated in Table 5.1.2, the average household size of the sample farmers is 7 people. Households have an average of 4 children below the age of seven, but there is a considerable range of 3 to 12 children of that age category present in the households. The number of children is primarily dependent on the stage of the family life circle. Household size converted into adult male labour equivalent[15] results in an agricultural labor force of 3.5 adult male equivalents per household for the whole sample with a very small and insignificant difference between the two groups under study.

This study focuses to a large extent on the utilization of household resources for consumption purposes. To obtain a more meaningful food consumption and nutrition assessment, household size is therefore converted into respective adult male consumption equivalents. This was done according to WHO/FAO conversion factors[16]. For the whole sample the average adult male consumption equivalent is 5,7. There is a noticeable but statistically insignificant difference between CBC and LBC owners of 5,5 and 6,0 in consumption equivalents, respectively.

Table 5.1.2 Household characteristics

	Household size	No. of children	Agricultural	Household size

[15] Conversion factors and calculations are depicted in section 4.3.1.
[16] Conversion factors and calculations are depicted in section 4.3.1.

	(heads)	(heads)	labour force (adult male equiv.)	(consumption equiv.)
sample mean	7 (2,3)	4 (1,6)	3,5 (1,5)	5,7 (2,1)

Notes: Number in parenthesis are standard deviations

Source: Compiled by the author with survey data.

Indicated in Table 5.1.3, the age distribution of all farmers of the two sub samples is the same. The average age of the household head (husband) is 44. The average age of the wife of the household head is 35. A significant negative correlation exists between the level of formal education and age, which is not uncommon for Ethiopia (UNICEF, 1993). Younger households are better educated in terms of years of formal school education. This difference is even more explicit for the education of the wives of the sample households. The wives of CBC households attended significantly (0,04 percent level) more years in school. Still, the rate of illiterate farmers is very high, which resembles the country situation (UNICEF, 1993).

Table 5.1.3 Average age and formal school education of husband and wife by technology group

	Age of husband	Age of wife	Formal years in school: Husband	Formal years in school: Wife
CBC	45 (14,9)	35 (11,7)	4 (4,1)	3 * (2,8)
LBC	43 (14,9)	35 (11,8)	2 (4,0)	0,8 * (1,8)

Notes: Number in parenthesis: Standard deviation.
*) Difference between CBC and LBC: Significant at the 0.05 level

Source: Compiled by the author with survey data.

5.1.2 Health and Sanitation Environment

The health and sanitation environment is closely related to the nutritional status of children. The accessibility of health services, prevailing diseases and the general sanitation environment of the survey households is therefore outlined in this section.

The survey area has two government hospitals and one NGO-run clinic. Even for remote farmers they are reachable within a half-day walk. The NGO clinic provides subsidized services and medicines, which the farmers are aware of. In rural areas government health assistants are trained as extension workers to visit the PAs for vaccination programs which are free of charge. Infants in Ethiopia are vaccinated against common diseases, such as measles, polio, whooping cough, TB, and diphtheria. Nevertheless, the number of doctors, nurses and health workers in rural areas is small[17]. During vaccination programs, which are taking place at sight in the villages, mothers are taught about the basic health and nutrition requirements of the family.

In the survey area latrines are not common. People generally use open fields. Only very few protected water sources are found in the PAs. These are force pumps or protected wells. The majority of the survey households obtain water from unprotected sources, such as rivers and springs. The water quality is perceived to be 'good' to 'medium' by the surveyed household wives, who have to walk on average 500-750 meters to fetch water. This is done two to three times a day. Water quality is perceived to be worse during the rainy season, because the rain washes mud and dirt into the rivers and springs. Some households collect roof water during the rains or dig a hole for more convenient water supply.

The two most prevalent health problems among adults as well as children are pneumonia and diarrhea. A primary factor believed to be responsible for the transmission of disease especially in the case of diarrhea is water of insufficient quality (Martorell, 1995). Whether water is obtained from protected or unprotected sources is an important aspect of sanitation and has been identified as an underlying cause of child malnutrition in Ethiopia (UNICEF, 1993). The perception of the surveyed household wives about the water quality would have to be certified by biochemical tests like bacteria counts to be able to draw conclusions about its influence on the survey children.

[17] The ratio of doctors, nurses and health workers to the population is one of the lowest in the world (one doctor per 31360 people, one nurse per 13250 people, one health assistant per 4797 people (UNICEF, 1993).

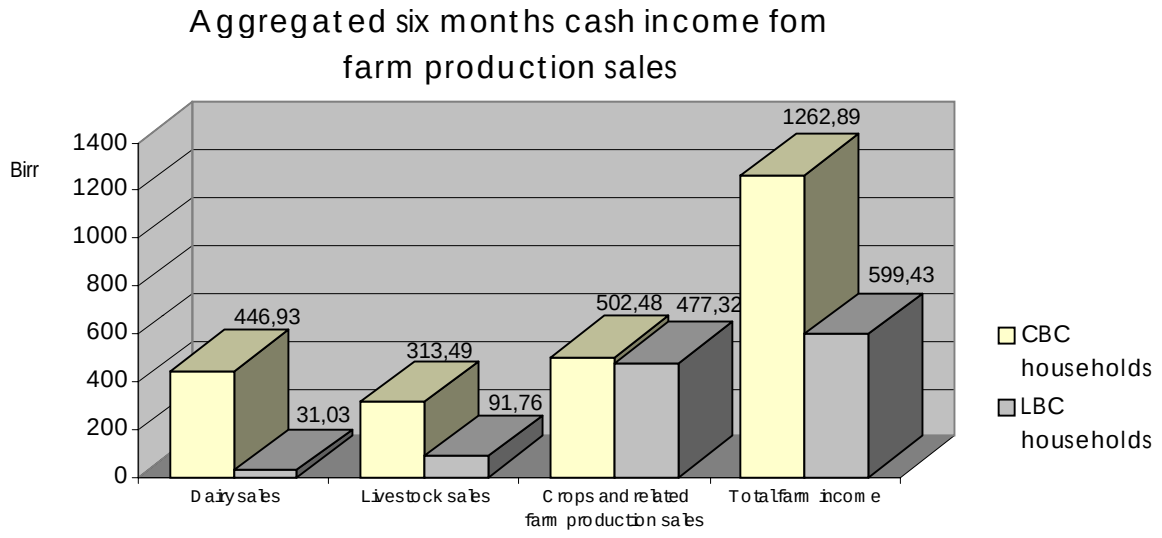
5.2 Consequences of Dairy Intensification and Commercialization

5.2.1 Increased Commercialization of Dairy Production and Resulting Income Changes

Comprehensively discussed in section 3.3.2.3, milk yields of crossbred cows in intensified smallholder production systems can exceed those of local cows by up to six, even eight times. In a conducive peri-urban marketing environment this leads to doubling, even tripling of farm cash income (Gryseels et al. 1984; Buta 1996). Dairy intensification concurrently leads to higher expenditures on inputs for CBC adopters, since they need to allocate 0,5 ha of their crop land to fodder production and have extra expenditures on feed concentrates, animal health and a.i. services. This will be discussed in the next section. In this section survey results on differences in income and in income control between CBC and LBC farmers are presented and discussed.

As indicated in Diagram 5.2.1, aggregated cash income recorded over the period of six months (October 1996 - March 1997) is more than twice the amount for farmers with intensified dairy production techniques then for farmers using traditional production methods. While CBC households earned the total of 1263 birr from the sale of their farm produce, LBC households earned 599 birr.

Diagram 5.2.1



Source: Compiled by the author with survey data.

Comparing all farm income sources aggregated into three main categories - dairy sales, livestock sales, crops and related farm production sales - between the two groups, it becomes evident that the largest difference is in sales of dairy products. CBC owners receive a multitude more cash income from the sale of dairy products than control farmers, 447 birr to 31 birr, respectively. This difference is attributable mainly to liquid milk marketing. But CBC owners also have three times more cash income from livestock sales, primarily from sales of cattle and particularly crossbred cattle, which achieve much higher prices at the market. The project actively supported the maintenance of a high calving rate and therefore it is not surprising that CBC adopters where able to sell more animals. The difference between cash crop and related farm production sales is negligible.

In Table 5.2.1 total household cash income received over the six month period is presented. CBC owners have more off-farm income, which is mainly due to wage labor and retirement payments. But the difference in off-farm income between the two groups is not significant and the share of off-farm income to total cash income is slightly lower for CBC households then for LBC households; 11 percent compared to 16 percent, respectively.

Table 5.2.1 Cash income from farm production sales and off-farm sources by technology group

	CBC		LBC	
Income source (Birr)	Average	CV	Average	CV
Dairy sales **	446,9	0,88	31,1	2,97
Animal sales *	313,5	1,69	91,1	2,26
Crop sales	502,5	1,06	476,9	0,66
Total income from farm production **	1262,9	0,66	599,1	0,61
Total off-farm income	162,7	2,19	109,3	3,13
Total income **	1425,6	0,66	708,4	0,65

Notes: CV: Coefficient of variance (standard deviation/mean)
**) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level

Source: Compiled by the author with survey data.

The above presented results document that the difference in cash income between CBC and LBC farmers is predominately attributable to the additional dairy sales. Likewise important are the higher returns from the sale of animals, which are inseparably related to the intensification technologies.

5.2.1.1 Differences in Wife's and Husband's Cash Income

An important issue is who controls the income from the new commercialized dairy activity, husband or wife. Explained more detailed in section 3.3.3, dairy operations under traditional farming practices are the dominion of women and it is reasonable to assume that they retain the money form dairy sales the purchase of household consumption items. It has been reported that under the intensified dairy production scheme large quantities of fresh milk available are marketed by men (MoA/FINNIDA, 1992). Whether the additional income controlled by men is of equal benefit for the whole households is not known.

In Table 5.2.2 monthly cash income from dairy sales is presented separately for husband and wife for the main products, fresh milk and *kebe* and *ayib*. Consistent with previously reported observations (MoA/FINNIDA, 1992; Pankhurst, 1996), husbands of CBC households are found to gain the largest part of the additional dairy income. They sell fresh milk to the DDE collection centers, where, during the study period, 1,00 birr was paid per liter of milk. Not surprising, husbands of LBC households do not undertake any milk sales. Their overall dairy income is negligible. Apparent from the results documented in Table 5.2.2, the often anticipated negative effect on female control over income does not take place. Wives of CBC households earn twice as much cash income through sales of *kebe* and *ayib* then LBC wives. Furthermore, wives of CBC households gain even more cash income through the sale of fresh milk then they gain from *kebe* and *ayib* sales.

Table 5.2.2 Monthly dairy income from fresh milk, *kebe* and *ayib* sales of wife and husband by technology group

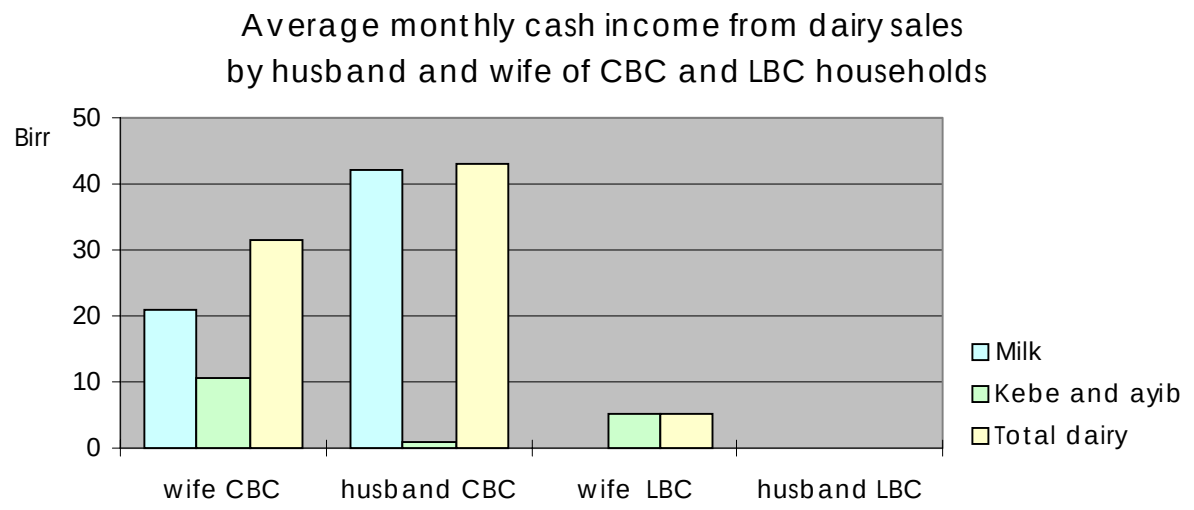
		CBC		LBC	
(Birr/month)		Average	CV	Average	CV
Milk sales	Husband **	42,1	1,24	0	-
	Wife *	20,8	2,41	0,0	-
Kebe and ayib sales	Husband	1,0	3,71	0,8	6,22
	Wife	10,6	1,54	5,1	2,93
Total dairy sales	Husband **	43,1	1,24	0,8	6,22
	Wife **	31,4	1,78	5,1	2,93

Notes: CV: Coefficient of variance (standard deviation/mean)
**) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level

Source: Compiled by the author with survey data.

Easily observable from Diagram 5.2.2, the distinction between male and female responsibilities in marketing of dairy products is not as rigid as expected. As a consequence of the dairy intensification technologies, women increase their cash income from dairy sales substantially.

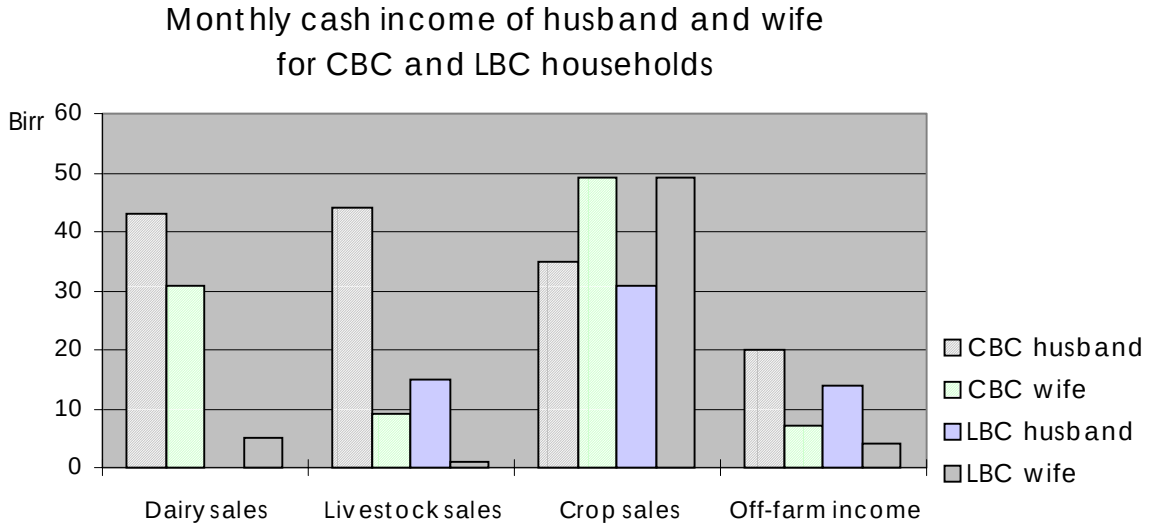
Diagram 5.2.2



Source: Compiled by the author with survey data.

Diagram 5.2.3 is summarizing monthly cash income of wife and husband from all major farm enterprises and off-farm activities for CBC and LBC households. It illustrates impressively the substantial differences in dairy income and livestock income between CBC and LBC households, compared to less pronounced differences for crop sales and off-farm income.

Diagram 5.2.3



Source: Compiled by the author with survey data.

5.2.2 Changes in Expenditure Patterns

Expenditures documented in the following section are cash expenditures on farm inputs, food, and nonfood commodities. Expenditure levels and expenditure patterns are expected to change as a result of higher and readily available cash income from the dairy operations. This has been documented for several commercialization schemes (v. Braun, 1995).

In Table 5.2.3 six months (Oct. 1996 to March 1997) cash expenditures on farm inputs by CBC and LBC households are presented. The results are also visualized in Diagram 5.2.4. Resulting from the intensified dairy production, higher costs for purchased inputs into animal production occur for CBC households. Whereas LBC farmers on average have negligible purchases of animal feed and spend not even one birr on animal health or a.i. services, CBC households have substantially higher expenditures for animal feed and animal health and a.i. services. But CBC households also purchase more fertilizer and seed. The costs for farm inputs covered by women are very small. All expenditures on farm inputs can be attributed to be the responsibility of men.

Table 5.2.3 Cash expenditure on farm inputs by technology group

	CBC		LBC	
Expenditure type	Average	CV	Average	CV
Seed	34,4	2,11	11,8	3,44
Fertilizer and herbicide [c]	301,4	1,68	218,1	1,07
Animal feed **	114,2	1,30	8,6	2,33
Livestock purchase *	171,9	1,95	43,0	3,46
Animal health and a.i. **	15,0	0,96	0,7	3,34
Total	636,9	1,11	282,1	0,94

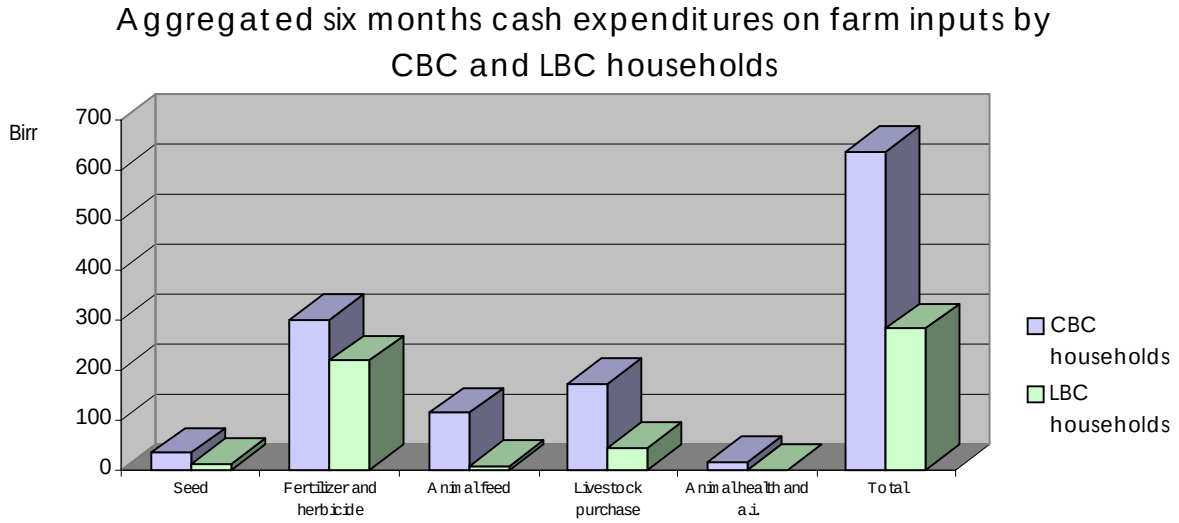
Notes: CV: Coefficient of variance (standard deviation/mean)
**) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level
c) Predominately purchases of fertilizer, mostly undertaken January to March

Source: Compiled by the author with survey data.

A simple calculation, relating increases in expenditures on inputs into the livestock enterprise to increases of income from livestock and dairy sales, reveals that the shift from traditional farming practices to intensified dairying leads to a 5,3 times higher income from the latter activity, as opposed to only 4,7 times higher expenditures related to it. In other words, although rising income is accompanied by rising expenditure due to the technology requirements, CBC farmers are left with an incremental income from dairy intensification and

commercialization. At the next level, it will be closely examined how the incremental income is utilized for household needs.

Diagram 5.2.4



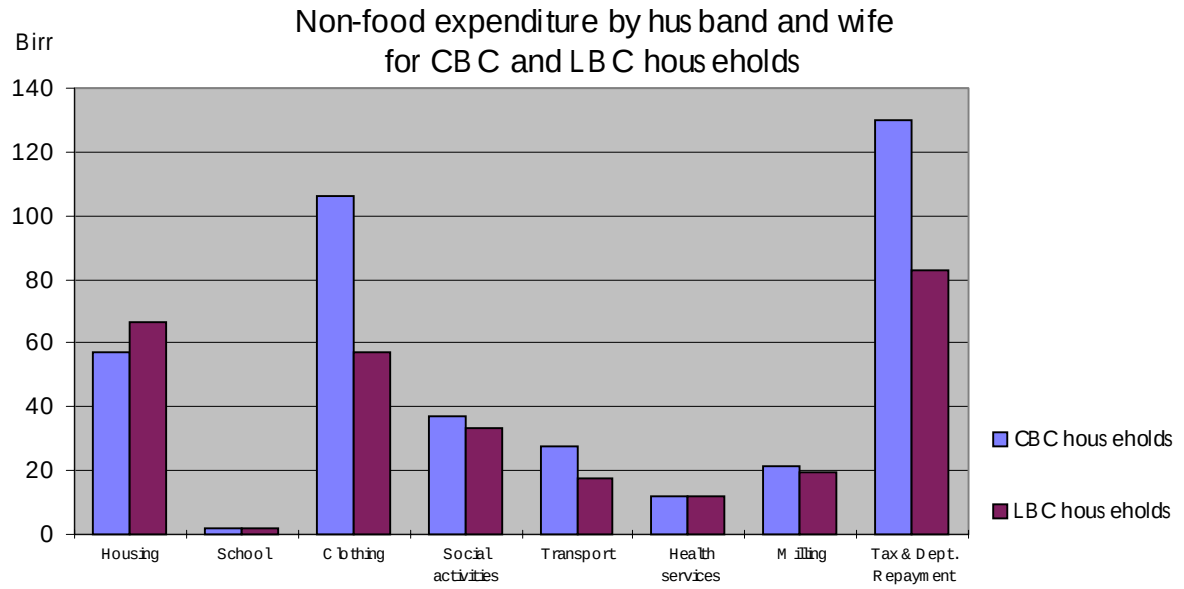
Source: Compiled by the author with survey data.

5.2.2.1 Expenditure on Food and Non-food Household Items

Discussed in chapter 2.3.3, research elsewhere has shown that wife and husband have different responsibilities to provide for family needs utilizing the respective income they control. Expenditure patterns usually depend upon the amount of money they have at their disposal and on social and cultural norms. It is widely believed that women spend disproportionately more income on food (Quisumbing et al., 1996). A comprehensive analysis therefore has to carefully investigate if changes in control over income occur between husband and wife and if these changes adversely affect food consumption and nutrition.

Diagram 5.2.5 illustrates six months cash expenditures on non-food commodities and services by CBC and LBC households. This comparison documents that there are only two categories of non-food expenditures which differ markedly between the two groups of farmers. These are expenditures on cloths as well as tax and debt repayments. Survey results further reveal that it is the wives of the CBC households who spend their additional income on increased purchases of cloths, whereas tax and debt are predominately undertaken by husbands of the CBC households.

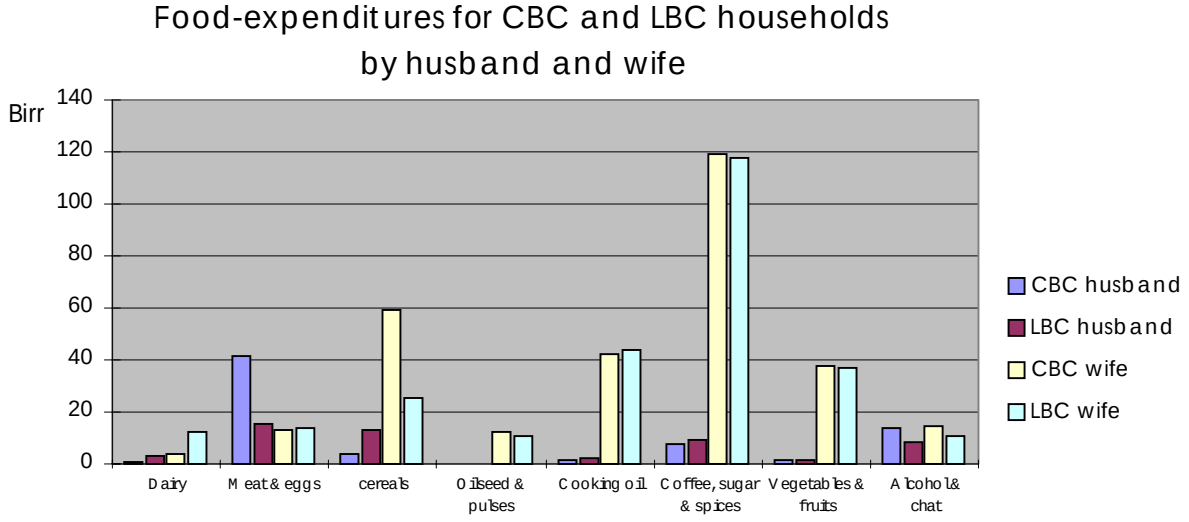
Diagram 5.2.5



Source: Compiled by the author with survey data.

Survey results clearly support the statement that husband and wife have different responsibilities to provide for family needs. This becomes even more evident from the data illustrated in Diagram 5.2.6, in which cash expenditures for different food commodities are depicted separately for husband and wife of CBC and LBC households. It is the wives of both categories of households who purchase almost all foods consumed. The only prominent purchases husbands undertake are livestock products (meat and eggs) and alcohol and chat[18]. Differences between CBC and LBC households in general exist for purchases of cereals, meat and eggs and dairy products. But wives of CBC households do not buy dairy products to the extent wives of LBC households do. It can be assumed that this is a consequence of the larger quantities of dairy products available from own-production. Wives of CBC households buy cereals twice the value of cereal purchases by wives of LBC households. Husbands of CBC household buy meat and egg twice the value of that by husbands of LBC households.

Diagram 5.2.6



Source: Compiled by the author with survey data.

[18] Chat is a drug consumed in many parts of Ethiopia. Chat purchases by the survey households were extremely rare. The majority of purchases are on alkohol.

5.2.3 Effects on Food Consumption

Briefly summarizing what has already been discussed in chapter 2.2, several studies document that technological change and commercialization of smallholder agricultural production improves the level of food consumption of participating households (Pinstrup Andersen et al., 1995; v. Braun and Kennedy, 1984). Changes in food consumption are generally associated with more readily available cash income, but increased commercialization can also lead to increased self sufficiency through increased land and labor inputs into subsistence food production and changes in cropping patterns (v. Braun et al., 1989). With higher income a substitution of cheap calories for more expensive calories often takes place and diets gain in quality and diversity (Behrman and Kenan, 1993), nevertheless consumption and nutrition effects by technological change and commercialization have more often been attributed to income increases rather than higher milk availability (v. Braun and Binswanger, 1991; Alderman, 1987). These direct and indirect consequences of smallholder dairy intensification and commercialization in the Ethiopian Highlands are examined in the following section.

5.2.3.1 Quantity and Quality of Household Food Consumption

The USDA has fixed the minimum calorie requirement for Ethiopia at 2088 cal per day per male adult equivalent (USDA, 1996). This is a very rough generalization but still a useful reference, although it does not take into account individual activity levels and energy needs. Out of all surveyed households 30 percent do not meet this requirement, the majority belonging to the LBC owner group.

To allow a more thorough analysis of differences in food consumption between the two groups under study, it is necessary to compare energy as well as nutrient consumption. As indicated in Table 5.2.4, intensified dairy production and commercialization is associated with significant increases in energy intake. CBC households consume 15 percent more calories than LBC households. This difference in energy intake corresponds to more fat and protein in the diet. CBC households consume almost 40 percent more fat and 15 percent more protein per adult equivalent. This research has also paid particular attention to micronutrient deficiencies. It is therefore promising to observe that the retinal content of foods consumed by CBC households is increased significantly. Retinal is a precursor of vitamin A exclusively derived from animal products.

Table 5.2.4 Energy and nutrient consumption per day by technology group in adult equivalents

	Food components						
(per day/ adult equivalent)	Calories cal	Fat g	Protein g	Carbo-hydrates g	Retinal µg	Iron µg	β-carotene iu
CBC	2503.6**	25.0**	75.1*	512.6	36.1*	236.9	1809.3
	(0.2)	(0.5)	(0.2)	(0.2)	(2.0)	(0.3)	(0.8)
LBC	2167.8**	17.8**	65.0*	543.7	7.7*	206.7	1871.3
	(0.2)	(0.4)	(0.2)	(1.1)	(2.0)	(0.5)	(1.1)

Notes: Numbers in parenthesis: Coefficient of variance (standard deviation/mean)
**) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level

Source: Compiled by the author with survey data.

Table 5.2.5 illustrates the diet composition of CBC and LBC households, which is expressed by shares of calories obtained from different food groups. Calories consumed in the form of dairy products is almost four times higher for CBC households. Likewise calories from staples and pulses are increased. Nevertheless, the actual shares of different food groups expressed in percent of total energy obtained from all foods consumed, do not differ substantially between the two surveyed groups.

Table 5.2.5 Diet composition by technology group expressed in share of calories in selected food groups

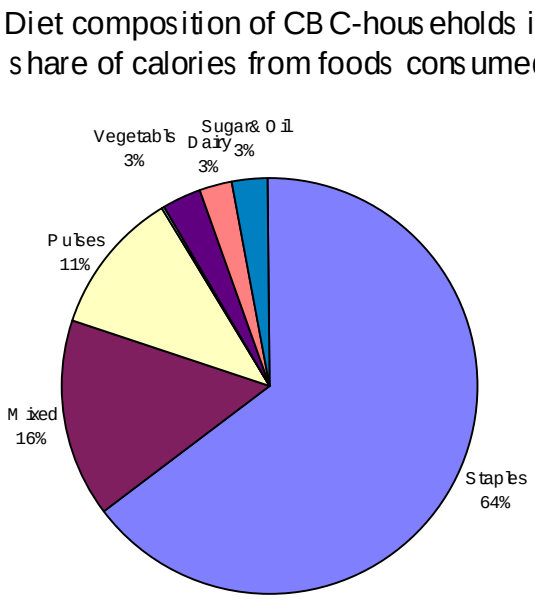
	CBC		LBC	
(calories/food group/ adult equivalent/day)	calories	percent	calories	percent
Staples	1585	64	1466	68
Mixed [a]	382	15	380	17
Pulses **	281	11	162	8
Meat	7	0	9	0
Vegetables	75	3	67	3
Sugar and oil	66	3	51	2
Dairy *	66	3	18	2
Total **	2462	100	2153	100

Notes: **) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level
[a]) Mostly *Kollo*, a local snack which is a mixture of whole grains and where often pulses are added

Source: Compiled by the author with survey data.

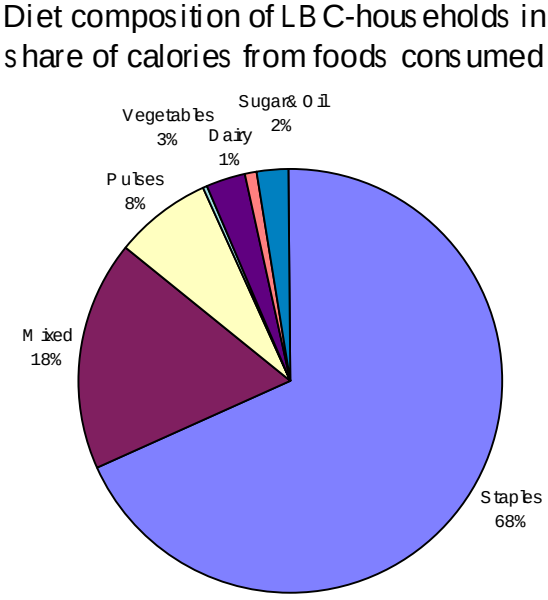
To visualize differences in diets, Diagram 5.2.7 and Diagram 5.2.8 illustrate diet composition of CBC and LBC households expressed in shares of calories of different food groups from all foods consumed as depicted in Table 5.2.5. A distinct difference between the two groups, CBC and LBC, is not discernible except for the slight differences in dairy products and pulses consumed.

Diagram 5.2.7



Source: Compiled by the author with survey data.

Diagram 5.2.8



Source: Compiled by the author with survey data.

5.2.3.2 Milk Consumption

Particularly the difference in intake of retinal, which is a precursor of vitamin A exclusively derived from the consumption of animal products, furthermore the increased amount of calories from dairy products lead to the assumption that CBC households consume more dairy products than LBC households. This is further emphasized by the assessment of per capita average weekly milk consumption which is presented in Table 5.2.6. All family members of CBC households profit from the higher milk yields. While priority in domestic milk consumption is clearly given to children, women and men gain as well. It should be further noted that although CBC households increase their milk consumption, they still market a far higher share of the produce than LBC households. This is unusual, because in dairy intensification schemes in other parts of the world, farmers have been found to market much higher shares of their dairy produce, leaving them with relatively small amounts for home consumption (Alderman, 1987; v. Braun and Binswanger, 1991).

Table 5.2.6 Average weekly milk consumption by technology group disaggregated for family members

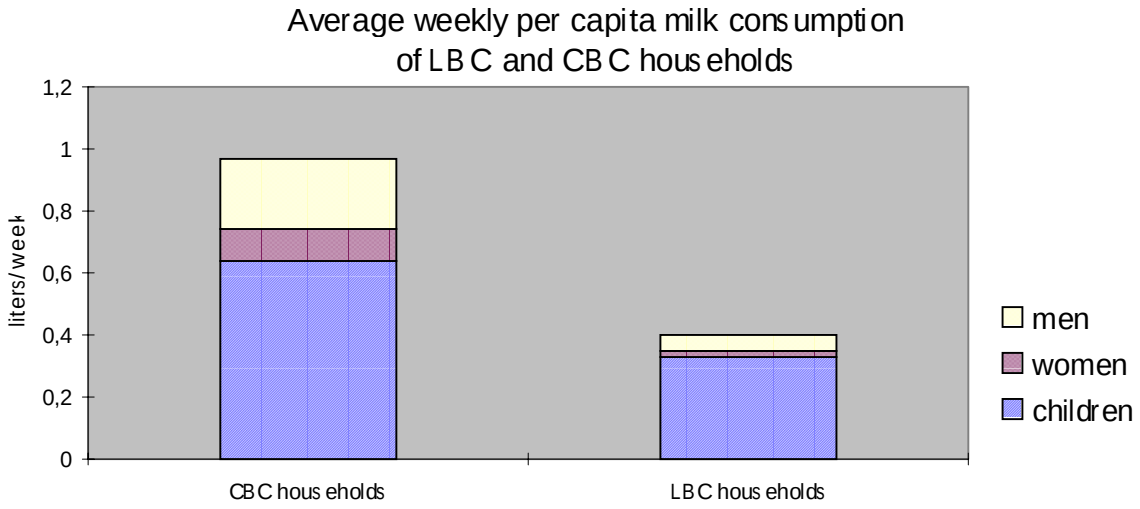
	Average milk consumed in liters (l/per capita/week[a])				
	Children	Women	Men	Household (l/adult equiv./week[a])	Household milk consumed/ milk produced (in percent)
CBC	0.64[+]	0.10*	0.23*	0.44*	13.5**
	(1.5)	(2.1)	(2.5)	(1.3)	(1.3)
LBC	0.33[+]	0.02*	0.05*	0.21*	38.9**
	(2.2)	(3.0)	(2.8)	(2.0)	(0.7)

Notes: Numbers in parenthesis: Coefficient of variance (standard deviation/mean)
[a]) aggregated milk consumption over 6 months divided by 24.
**) Difference between CBC and LBC: Significant at the 0.01 level
*) Difference between CBC and LBC: Significant at the 0.05 level
[+]) Difference between CBC and LBC: Significant at the 0.1 level

Source: Compiled by the author with survey data.

To visualize the milk consumption increases of men, women, and children of CBC and LBC households Diagram 5.2.9 illustrates the differences between the two groups of survey households.

Diagram 5.2.9



Source: Compiled by the author with survey data.

5.2.4 Effects on child nutrition

Survey results presented in the previous sections document that incremental income from the commercialized dairy activities is accompanied by increased expenditures, not only the rather unavoidable increased inputs into the livestock enterprise, but also on food and non-food commodities. Furthermore, calorie consumption of CBC households is significantly higher than that of LBC households. At the level of individual household members, increased milk consumption is identified to occur for men, women, and children of technology adopting households. Evidence from research elsewhere suggests that these positive consequences of intensification and commercialization schemes do not necessarily translate into similar improvements of child nutrition (v. Braun and Kennedy, 1994). Therefore the study includes another survey component, the assessment of differences in the nutritional status of CBC and LBC children. This assessment is augmented by the discussion of other factors likely to affect child nutrition, like the health and sanitation environment, mothers' nutritional knowledge, their formal school education and the 'care' a child receives.

The assessment of differences in the nutritional status of all preschool children of the surveyed households (131) age 6 months to 6 years was conducted by means of

anthropometric measurements, explained in chapter 4.2.2. Wasting[19], a measure to indicate acute food deficit, was not found in any of the children in the sample survey. Depicted in Table 5.2.7, stunting[20], a parameter used to indicate chronic malnutrition, was found in 38 percent of all children. This is far lower than the average of 64 percent for all children of this age group in rural Ethiopia (NNSS, 1993).

Table 5.2.7 Prevalence of chronic malnutrition among preschool children of CBC and LBC households

	CBC		LBC		Total	
	No. of children	Percent of CBC children	No. of children	Percent of LBC children	No. of children	Percent of total children
normal (≤ 2 SD)	42*	74%	39*	53%	81	62%
stunted (≥ 2 SD)	15*	26%	35*	47%	50	38%
	57	100%	74	100%	131	100%

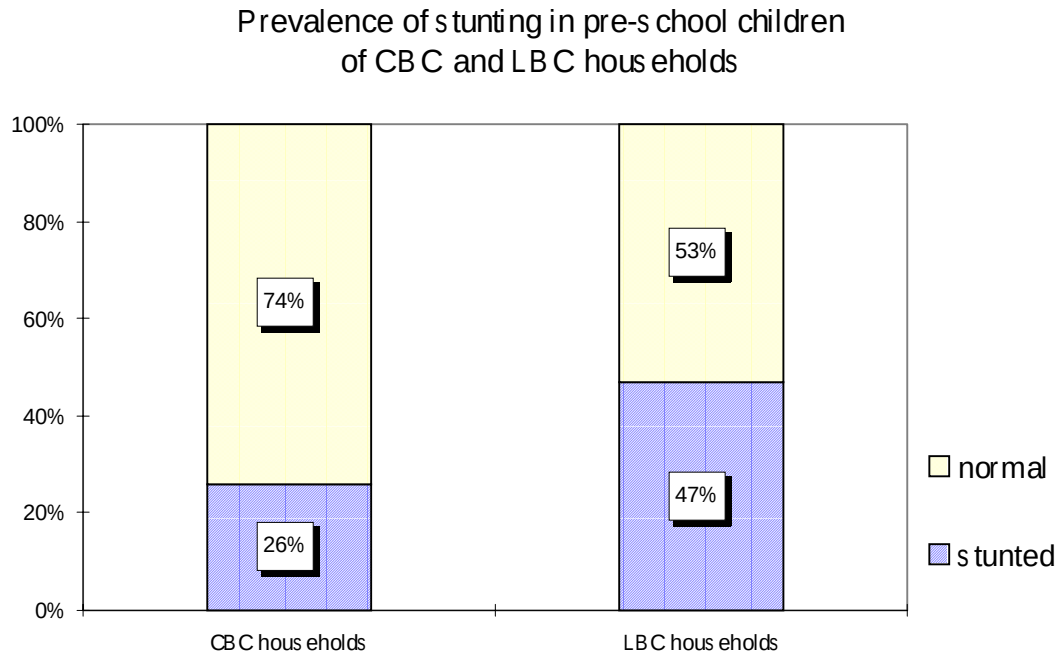
Notes: SD: standard deviation
*) Difference between CBC and LBC children: Significant at the 0.05 level

Source: Compiled by the author with survey data.

There is a significantly lower prevalence of stunting found in children of CBC households compared to LBC households; 26 percent to 47 percent, respectively. The differences in the prevalence of stunting between children of CBC and LBC households are illustrated in Diagram 5.2.10.

[19] wasting is a weight for height measurement indicating the prevalence of acute undernutrition by standard deviations from the median of the reference population; standard deviation ≥ 2 indicates wasting (WHO, 1993)
[20] stunting is a height for age measurement indicating the prevalence of chronic malnutrition by standard deviations from the median of the reference population; standard deviation ≥ 2 indicates stunting (WHO, 1993)

Diagram 5.2.10



Source: Compiled by the author with survey data.

5.2.4.1 Health and Child Care

Significant differences in morbidity between children of CBC and children of LBC households could not be discovered. Likewise only a very few incidences of illness had been recorded in the questionnaire. This could likely be caused by embarrassment to talk about health problems. When mothers were asked what they would do when they find their child having diarrhea the majority replied that they would take the sick child to the hospital immediately or after traditional healing methods did not help. Only in one case a remark was made that the family would not afford to take a sick family member to the hospital.

Apart from this encouraging behavior, potentially harmful beliefs and practices are quite frequent. Almost 30 percent of all surveyed mothers think that the reason for diarrhea is *quecceat* (twisted body). Often the incidence of disease is associated with *buda* (evil eye). In this case a traditional healer called *wegassa*, practicing local modes of physiotherapy and surgery is visited to take care of the child. Children are also taken to a *wegassa* for the removal of tonsils or even forceful extraction of the canine-teeth. These practices are found to cause infections and in some cases even the death of the child (UNICEF, 1993).

The number of vaccinated children of the surveyed mothers is quite high. Almost 70 percent of the families have all or at least half of their children vaccinated. Another 20 percent has at

least one child vaccinated. This adds up to almost 90 percent of all surveyed households having at least once taken part in a vaccination program.

A distinct factor influencing child nutrition is the care a child receives. This concept has been described in section 2.3.2. The factor 'care' is generally not easy to measure (Engle et al., 1997). Nevertheless a few indicators of care exist, which can be identified to be of particular importance in the Ethiopian context. Presented in Table 5.2.8, most of these indicators do not differ much between the two groups of households. Nevertheless, as depicted in the first section of this chapter, mothers of CBC households received significantly more years of formal school education, a very important determinant of child nutrition (Behrman, 1995) closely associated with care (Engle et al., 1997). Still, the scores ranking nutritional knowledge of mothers as identified in the questionnaire do not differ between the two groups. Feeding new born children fresh butter, juice of enset, or black incense etc. in stead of the colostrum is reported to be specifically contributing to the prevalence of stunting in small children in Ethiopia (NNSS, 1993). This practice of giving so called "laxatives" to new-born children occurs less often in CBC households. The questionnaire on maternal nutritional knowledge revealed the surprising fact that mothers in the survey area give "bottle milk" to small children. Milk is perceived as a supplementary food, especially given when mothers are absent for longer periods, for example, when they go to the market.

Table 5.2.8 Selected child care variables for CBC and LBC households

	CBC	LBC
Weaning age in months	24 months	26 months
Introduction of supplementary food in months	7 months	9 months
Percent of children given "laxative" [a] shortly after birth	64% *	88% *
Percent of children fed with "bottle milk" [b]	83%	73%
Percent of "bottle milk" children receiving boiled milk	85%	76%
Percent mothers who received formal education in school	50 % **	18 % **
Nutritional knowledge of mothers	6/12 scores	6/12 scores

Notes: *) Significant at the 0.05 level
**) Significant at the 0.01level

[a)] Before given breast milk, babies have to swallow small amounts of butter, yeast, a water/sugar solution or fenugreek because it is believed that this is necessary to clean their throat and stomach.
[b)] Starting from 2 weeks children is given cow milk in "bottles", because mothers consider this a necessary supplement.

Source: Compiled by the author with survey data.

6 Conclusions

This chapter returns to the hypothesis and objectives stated in chapter 1.2 in order to summarize the results of the study and draw conclusions about the linkages between smallholder dairy intensification in the Ethiopian highlands and improvement of smallholder welfare, in particular child nutrition. It will be discussed, to which degree conditions farmers are facing in the PUDT-Project can be regarded representative for periurban smallholders in the Ethiopian highlands as a whole. Finally, perceived weaknesses of the current study analysis and scope for further research will be elaborated on.

6.1 Conclusions Drawn from Study Results

The overall objective of the study was to assess the net effect of intensified dairy production on child nutrition. In this regard the first hypothesis, that d*airy intensification and commercialization of dairy production has an overall positive effect on child nutrition*, may be accepted. It was found that children of households who adopted dairy intensification technologies are better nourished. The indicator chosen to assess the state of child nutrition is the prevalence of stunting, which is reflecting chronic malnutrition. This growth parameter is significantly different between the two groups of children. 47 percent of the children from LBC household are stunted, whereas only 26 percent of the children from CBC households are stunted. Both estimates are markedly better than the country average of 64 percent stunting found in all children living in rural Ethiopia (NNSS, 1992).

One of the specific objectives of this study was to investigate the change in control over income from the sale of dairy products. This is an important issue, because the potential of agricultural change to improve the nutrition of individual households members is not only a mere technical question. Agricultural change and in particular commercialization induce a shift of rights, responsibilities, and resources, which can result in the impediment of the welfare of individual household members (Haddad et al., 1997). In the case of smallholder dairy intensification in the Ethiopian highlands, concerns about possible shifts of income from women to men are reasonable (section 3.3.1). A project resulting in less or relatively less resources controlled by women must be viewed as an indication of possibly forgone welfare benefits (Quisumbing et al., 1996). In this regard, the hypothesis that *mothers lose control over income traditionally gained from marketing of home produced butter and cheese, negatively determining child nutrition, because women are understood to have a higher propensity to provide for household calories*, must be rejected. The additional household income from dairy sales by technology adopters is substantial. A larger share is gained by the husband, still the wives of CBC households obtain three times more income

from dairy sales than a wives of a non-adopting households. Moreover, they do not only have more income from sales of butter and cheese, they likewise begin to sell liquid milk, which leads to the assumption, that the distinction between male and female responsibilities is less rigid than originally expected.

To further investigate the consequences of the substantially increased dairy income, cash expenditures on food and nonfood commodities have been compared between the two groups, also distinguishing the expenditure pattern between husband and wife. Increases in expenditures for cereals, livestock products, clothing, and tax and debt repayments exist. Nevertheless, in contrast to the sharp increases in income, increases in food and non-food expenditures appear relatively weak at first sight. This is acceptable, when considering the large increases in cash expenditures on inputs into the intensified livestock enterprise. Comparing expenditure patterns of husband and wife of all households, the distinct responsibilities become evident. While women provide for immediate household needs, such as cloths and food, men undertake almost all expenditures on inputs into the livestock enterprise and cover tax and debt repayments.

The next level of observation is household food consumption, augmented by the inclusion of data on milk consumption of individual household members. The objective was to document whether a difference is manifest between the direct effect of increased milk yield on child nutrition and the indirect effect of increased commercialization of dairy production on child nutrition. The question behind this is, whether dairy intensification and commercialization at the study site would improve child nutrition through changes in milk consumption per se, or rather through the potential for increasing incomes. Two hypothesis have been formulated in this regard. The first hypothesis states that *children will directly benefit (nutritional status) from intensified dairy production through higher milk yield available at the household.* In fact, children of CBC households consume almost three times more milk than children of LBC households. As addressed above, children of CBC households are also better nourished. Therefore the above stated hypothesis must be supported, even though the relationship between increased milk consumption and improved nutrition could not be quantified. In other words, the hypothesis can be supported, if it is accepted reasonable to conclude that CBC children are better nourished, because evidence found elsewhere has shown that milk consumption, particularly in the African context, has significant positive effects on health and nutrition of children (section 2.1.3). The second hypothesis, that *children will indirectly benefit from intensified dairy production through increased expenditure on food and health related expenditures* can be accepted to some extent. The results of the analysis show that expenditures on health services by CBC households and LBC households are the same. The

relationship between income and health expenditures is difficult to tackle and also very location specific (Engle et al., 1997). On one hand, from the survey results there is no reason to speculate that the children of CBC households are more ill than the children of LBC households, therefore expenditures do not have to differ. On the other hand, rural areas of Ethiopia are known for their high rates of child morbidity (UNICEF, 1993) and therefore the survey results in this instance should be regarded with some caution. Discussed above, cash expenditures on food by CBC households are increased, although not significantly. Contrary to this, per capita food consumption is markedly and significantly increased. CBC households consume more calories, protein, fat, and retinal than LBC households. Food consumption expenditures by smallholder households relying to a large extent on subsistence production may rather originate from consumption of farm production. Nevertheless, data on income and expenditures from farm production has not been available, therefore it is impossible to come to a final conclusion on this topic.

The third objective was to identify possible constraints to improvements in child nutrition which latent within the household and community environment. These constraints can be found in factors such as unavailability of health facilities, low education status of women, bad sanitation, or bad hygiene. The hypothesis formulated in this regard is that *major improvements in child nutrition are not realized if parents are uneducated, mothers do not have knowledge about nutritional requirements of their children, health facilities do not exist and sanitation and hygiene remain generally poor*. Respective factors have been observed as part of the analysis and it can be concluded that these poverty related determinants do influence the nutrition of children in the survey area as they do in most parts of rural Ethiopia. Nevertheless, the nutrition of the surveyed children is better, compared to the country average, but malnutrition is still prevalent at a high rate. At the same time, the above mentioned factors do not prevent that children of CBC households are better nourished then children of LBC households. It was also found that the important factor of differs significantly between the two groups of households under investigation. Wives of CBC households have spend significantly more years in school than wives of LBC households. Schooling, particularly of mothers, is an important factor positively affecting child nutrition, „because it seems to improve the information relevant to child health and nutrition that is used at the household level“ (Behrman, 1995, 52).

6.2 Concluding Remarks

Drawing a final conclusion, evidence from the current study analysis strongly suggests a very beneficial effect of dairy intensification and commercialization on smallholder welfare. Milk production and income increases from dairy sales are substantial. Although expenditures on inputs into the dairy enterprise are likewise raised considerably, returns from the dairy enterprise remain high. The technology itself does not appear to be 'gender neutral', but the effects of the technology, creating income earning possibilities for both, husband and wife, appear to be 'gender neutral'. Additional income is utilized to provide for family needs in such favorable ways, that ultimately the nutritional status of children from dairy technology adopters is significantly improved. The strong positive effect of the PUDT-Project participation on child nutrition is surprising and encouraging: Surprising, because such favorable effects have not been documented for other studies on smallholder agricultural commercialization and child nutrition cited in section 2.2.3. Encouraging, because Ethiopia is one of the countries with the worst state of child nutrition in the world (UNICEF, 1993), therefore improvements should accompany any sphere of activity. Micronutrients, in particular vitamin A, have been addressed explicitly in ILRI's research design in the conviction that increased amounts of livestock products available at CBC households will help to prevent micronutrient deficiencies. Milk consumption of children in Kenya and Mexico were positively associated with child development and children who received more milk exhibited a superior growth performance (Murphy, 1996). It seems reasonable to assume that this effect also took place at the survey site in the Ethiopian highlands.

The positive effects of the PUDT-Project on smallholder welfare, confirmed by the study analysis, should consequently result in further promotion of smallholder dairy intensification in the Ethiopian highlands. Nevertheless, this conclusion should be made with caution for two reasons. For one reason, because it is uncertain whether PUDT-Project farmers are facing 'real world situations'. Project farmers received considerable support to successfully run their dairy enterprise. Some of the health and a.i. services were given free of charge and in times when animal feed and concentrates were difficult to acquire, the project helped to supply them. At one point, the dairy cows were given hormones to maintain a favorable calving rate[21]. The enterprise may become a far more risky undertaking, if this support would not have been given, which could then lead to lower returns in terms of milk production, as well as cash income.

[21] This is information obtained from observations and conversations with people involved in the project at different levels.

It should secondly be noted, that smallholders retain relatively large shares of milk for home consumption. This is rather atypical for a dairy intensification scheme (v. Braun and Binswanger, 1991). Usually a nutrition effect would not be anticipated to occur as a direct consequence of increased dairy consumption, but would occur as an income effect, allowing for increased staple consumption from favorable terms of trade between dairy products and cereals (Alderman, 1987). A study examining the market situation and prices smallholders are facing in the survey area would be required to further investigate this atypical result.

Study results are based on a comparative analysis, because the quality of the available data was not sufficient to run a regression analysis on the variables identified in the model. Furthermore, it is a cross-sectional analysis, therefore it cannot be ascertained that differences between the two groups of households exclusively arise as a consequence of the adoption of the dairy technologies. If it is the better educated and wealthier farmers who adopted the technologies, it should be assumed that their children have been better nourished previous to the project. A different data set may facilitate a regression analysis, which unquestionably would yield further proof on this issue.

Two more shortcomings, which leave scope for further research shall be addressed. First, the survey data only covers a six months period. Under circumstances with strong seasonal differences in food production and consumption, it is unusual for consumption surveys not to cover year round data. This leaves the possibility for a twelve months data analysis, likely to yield interesting information. Secondly, the survey did not cover an assessment of total household income and expenditures. This would require estimation of crop yields and stocks. In a farming system characterized by a high degree of subsistence production, this is a serious lack of information and should be considered in subsequent studies.

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Appendix:

SURVEY ON: Maternal Nutritional Knowledge

Name of the Household Head (HH): _____ CBC owners: Yes☐ No☐

Woreda: _____ Kebele: _____ PA: _____

Please give complete record of all household members:

HH Members Name	Relation to HH head	Age	Sex	Education	Literacy status

Relation to HHH
1 father(HHH)
2 mother
3 HH child
4 sibling
5 adopted child
6 other

Education
enter number of years of formal education

Sex
1 male
2 female

Literacy status
1 read, not write
2 read and writ
3 do not read nor write

To the enumerator: Please answer the following questions according to your own knowledge:

a) Has the mother lost any children below the age of 6 because of death during the last 2 years? Yes☐ No ☐

If YES, please state the cause of death: ☐ 1- disease, ☐ 2- accident, ☐ 3- others

b) Does the house have a corrugated iron roof? Yes☐ No ☐

c) Which animals are found under the same roof as the family lives?

☐ 1- chickens, ☐ 2- sheep, ☐ 3- goats, ☐ 4- cattle, ☐ 5- equines, ☐ 6- none

Maternal Nutritional Knowledge and weaning practices

1. Have you ever participated in a village health or nutrition program such as for example primary health care, mothers' club classes, family planning volunteers, ...? Yes☐ No ☐

If YES, please tell the number of Programs in which mother participated:___

2. Are there any illnesses, diseases, or health problems many children in your village suffer from? Yes☐ No ☐

If Yes, please name these illnesses, diseases, health problems or describe the symptoms:

_____

3. Is there anything that you are told not to eat when you are pregnant or during some time after you gave birth to your child? Yes☐ No ☐

If YES:

What foods are you told not to eat: _____

Who told you about these foods? ☐ 1- mother, ☐ 2- husband, ☐ 3- other relative, ☐ 4-neighbour, ☐ 5- traditional herbalist, ☐ 6- health worker, ☐ 7- other

Why are they forbidden? _____

4. When a women is pregnant, does she *need* to eat less food, more food, or the same amount of food? ☐ 1- less, ☐ 2- more, ☐ 3- the same, ☐ 4- do not know

5. What is the first thing that you feed your new born children?
☐ 1- butter, ☐ 2- breast milk, ☐ 3-fenugreek,
☐ 4- water, ☐ 5-others (specify) _____

6. How long do you think your children *should be* breast fed?
Until the age of ___/___(years/months)

7. What was the age, when you weaned the last child?
At the age of ___/___(years/months)

8. What made you stop breast feed your last child? (open, various reasons possible)

_____

9. Do you give "bottle milk" besides breast milk?
☐ 1- Yes, every day. ☐ 2- Yes, sometimes. ☐ 3- No, never(or less than once a month.)

If YES, when do you start giving "bottle milk"? ____/____ (months/weeks)

…do you boil the milk? ☐ 1- always, ☐ 2- sometimes, ☐ 3- no if milk is fresh, ☐ 4- no

…why do you give "bottle milk"? _____

10. At what age do you start giving supplementary food(other than milk) to your children?
At the age of ___/___(years/months)

Do children eat supplementary food from the same bowl as the rest of the family?
☐ Yes ☐ No

What kinds of food do you supplement? (open) _____

_____

11. What do you do when you find your child has diarrhea? (open)

first: _____

second: _____

(What do you do, if you can not take the child to the clinic?) _____

_____

12. Why do children get diarrhea? (many answers possible)

_____

13. What are some foods that are needed to make the child grow up strong and healthy?

Note all names of foods mentioned: _____

Mother does not know any. ☐

Habits in Family Meal Intake

14. How does your family take meals? Is there a specific order in which the father, mother, children and other family members take the meal? Yes☐ No ☐

If YES, please fill in most appropriate code: Who eats first? _____
Who eats last? _____

Codes: 1- Adults, 2- Elders, 3- Father, 4- Mother, 5- Father and Mother, 6- Children, 7- Smallest children, 8- always together

Availability of Medical Service

15. Has any member of your household including yourself been seriously ill during the last year (not able to work, children with fever, diarrhea...)? Yes☐ No ☐

If YES, fill out table: Who was ill, and what was the illness/symptoms?

Relation to HHH (use codes from page 1)	Illness or Symptoms: (fever, cough, ...)

16. Did you take any of the above mentioned persons to somebody to seek help for recovery. For example to a clinic, local doctor, nurse, traditional herbalist? Yes☐ No ☐

If YES, where did you go and who was taken there (including yourself)?

Health Institution/Person visited	Relation to HHH (use codes from page 1)

If NO, what kept you from taking that person there? (open)

17. Did any of your children receive vaccination against any of the major killing diseases such as TB, measles, polio, whooping cough, diphtheria …? Yes☐ No ☐

If YES: Name each child who was vaccinated and tell the number of times it was vaccinated:

Name of Child:	Number of Vaccinations:

Water and Sanitation

18. What is the water source of the family?

Season:	Type of water source *):	Please let the mother range the water quality **):	Distance from house: (Enumerator, please give approximate.)
rainy season:			km
dry season:			km

codes: *) 1- protected well, 2- unprotected well, 3- pipe, 4- force pump,
5- river, 6- spring, 7- pond, 8- others(specify)

**) 1- good, 2- medium, 3- bad

19. Does the family use a dug hole as a watersource during the rainy season? Yes☐ No☐

If YES, what is the distance to the house? _____ meters