Food and Agriculture Organization of the United Nations

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Dairy Development's Impact on Poverty Reduction

Global Agenda for Sustainable Livestock

Dairy Development's Impact on Poverty Reduction

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PREFACE

Poverty and hunger eradication are among the greatest global challenges facing the world today and an indispensable requirement for sustainable development. Driven by population and economic growth, particularly in developing countries, the demand for livestock products is expected to increase substantially in the coming 30 years. The livestock sector can contribute to address these challenges by promoting a sustained economic growth, inclusive social development and an efficient use of natural resources.

Among the more than 900 million extremely poor (under the $1 per day poverty line) people of our planet, the majority lives in rural areas and depends on agriculture and livestock. More than 500 million extremely poor people depend predominantly on livestock and many of them on small and marginal dairying, be it with dairy goats or dairy cattle/buffalo.

To be able to show the role dairy development plays in lifting poor people out of poverty, the study under report is providing quantitative evidence on the potential impact of dairying on poverty reduction.

The Global Agenda for Sustainable Livestock, established in 2011, is a multi-stakeholder partnership mechanism with the aim to catalyze and guide the sustainable development of the global livestock sector. It provides a platform addressing comprehensively the sector's multiple challenges towards sustainable development by funneling the global dialogue into local practice change, focusing on innovation, capacity building, and incentive systems and enabling environments.

The achievements of the Global Agenda have proven that multi-stakeholder partnerships are a powerful cooperation approach to support the implementation of the Sustainable Development Goals (SDGs) on issues related to livestock.

The vision of the Global Agenda is to enhance the contribution of the livestock sector to sustainable development. Its mission is to enhance livestock stakeholders' commitment, investments and adoption of good practices and policies in support of the UN Agenda 2030 and its goal is to facilitate dialogue, generate evidence and support the adoption of good practices and policies in favor of the UN Agenda 2030 targets and objectives related to livestock. The sector's sustainability can only be improved effectively through concerted action by all stakeholder groups. Given the public good nature of the sector's environmental, social and economic challenges and its increasing economic integration, collective global action is essential.

Therefore, the strategic approach in the Global Agenda has evolved from a first phase where the seven stakeholder Clusters were the main focus to consolidate the multi-stakeholder vision, to a situation where the Action Networks have been prioritized to foster knowledge generation, pilots and practical impact at local level. The Action Networks are the specific technical initiatives the Global Agenda liaises with to foster concrete livestock sustainability aspects.

In this framework, the Livestock for Social Development Action Network, established in 2017, has initiated the production of a series of prospective papers on the impact of dairy on the most relevant social SDGs through the joint effort of the Global Dairy Platform (GDP), IFCN-Dairy Network and FAO, and the overall facilitation of the Global Agenda partnership. This publication corresponds to the first paper of the series.

Dairying is a powerful tool for rural poverty eradication. However, experiences from many countries show that it is not enough to just provide the technical knowhow for dairy development. All success stories include strong policy development components. Only with conducive public policies which allow to link small scale dairy producers to inputs, markets and capacity building measures the programmes have been successful.

I congratulate the authors of this report for showcasing the important role of dairy development towards achieving SDG 1, which is No Poverty.

Fritz Schneider

Chair
Global Agenda for Sustainable Livestock

This study was carried out by M.J. Otte and A. Felis-Rota and benefitted from constructive comments provided by E. Reyes, U. Pica-Ciamarra, F. Schneider.

SUMMARY

Background

In 2015 the 193 Member States of the United Nations adopted the Sustainable Development Goals (SDGs), which aim to end poverty (SDG1) and hunger (SDG2) while restoring and sustainably managing natural resources. Given the importance of livestock in poor people's livelihoods, livestock sector development, and particularly development of the dairy sector, is regarded as a promising avenue for supporting the achievement of SDG1. To underpin the case for dairy development as an avenue for poverty reduction, this study assessed the evidence for a causal relationship between dairy development and poverty reduction / improved household welfare.

Approach

A systematic literature search was conducted to identify studies providing quantitative information on the potential impacts of dairying on poverty reduction and socio-economic development. To maximise the validity of causal inference, only randomised controlled trials and observational studies with a comparison group, in their vast majority rigorously controlling for confounding, were included in the group of studies used for the quantitative assessment of the impact of dairying on household welfare. Additionally, papers quantifying employment generation in downstream value chains and papers taking an economy-wide approach using input-output relationships for dairy production and processing were included to assess the effects of dairying beyond producer households.

Findings

Across all household-level studies, dairy cow ownership and/or improvement of dairy cow production consistently had a substantial positive and nearly always statistically significant impact on a wide range of indicators. This finding and its consistency across study types, countries and indicators provide strong evidence that engagement in dairying was the cause rather than the result of higher household welfare. The dairy value chain studies showed that milk collection and distribution generated a considerable amount of direct and indirect employment while employment generation by processing and retail depended on the dominant product types. Formal economy-wide assessments of the economic impacts of dairy sectors suggest that the indirect and induced impacts are at least as large, if not larger than the direct impacts. Thus, the reviewed literature provides strong evidence that in specific settings dairy development makes a significant contribution to poverty reduction, both at household and community level.

Recommendations

Use of a common conceptual framework for better understanding the inter-linkages between dairying and household or community welfare combined with a set of agreed impact indicators would significantly enhance the utility of future research endeavours. Also, more comprehensive sector-wide studies are required for a fuller understanding of the potential contribution of dairy development to SDG1. Given the diversity and technical as well as institutional complexities of dairy supply chains, dairy development strategies need to be carefully tailored to specific contexts and must consider efficiency and competitiveness of all actors in the dairy chain.

INTRODUCTION

Food security and poverty reduction are central to the world development agenda. Within the global food production and distribution system, poverty reduction strategies have renewed the focus on the the potential contributions of livestock to enhancing the livelihoods of smallholder farmers.

Assessing Linkages between Livestock and Poverty Reduction

In 2015 the 193 Member States of the United Nations adopted a set of 17 Sustainable Development Goals (SDGs) to guide development actions of governments, international agencies, civil society and other institutions over the next 15 years (2016-2030). The SDGs aim to end poverty (SDG1) and hunger (SDG2) while restoring and sustainably managing natural resources.

Worldwide, some 900 million poor people live on less than US$1.9/day (World Bank 2015). About half of them depend directly on livestock for their livelihoods. To poor people, farm animals are a major asset, representing both capital and, in many cases, a source of income, while at the same time being a source of high quality nutrients. Livestock, which can be sold in times of crisis, act as household insurance. On the farm, they provide draught power and fertilization, and reward their owners with a wide diversity of products ranging from milk, meat and eggs to hides, skins, leather and wool. Livestock therefore contribute to three major pathways out of poverty by: (1) increasing resilience (2) improving smallholder and pastoral productivity and (3) increasing market participation (ILRI 2008).

Given the importance of livestock in poor people's livelihoods, livestock sector development is regarded as a promising avenue for **supporting the achievement of SDG1** and a large body of literature exists on livestock sector development and poverty reduction (e.g. FAO 2012, Upton 2010, van't Hooft et al. 2012)

However, in order to reinforce livestock's role in poverty eradication, it is important to obtain more accurate information on the number and characteristics of poor livestock keepers and of workers along livestock supply chains. Another priority is to gain a better understanding of how livestock can best be used to reduce poverty.

Within livestock, the dairy sector is regarded as carrying particular promise to contribute to SDG1. It has been estimated that almost 150 million farm households, i.e. more than 750 million people, are engaged in milk production, the majority of them in developing countries (FAO 2010). Annual milk consumption growth rates in these countries is at least double the growth rates of major staple foods and due to the perishability of dairy products the bulk of dairy production is consumed domestically without entering international trade (Gerosa and Skoet 2012).

Therefore, potential for **future expansion of dairy production in developing countries remains significant** and, if properly directed, dairy sector development could serve as a powerful tool for reducing poverty.

Much of the literature linking dairy sector development to poverty reduction, however, is conceptual and qualitative and, to date, no attempt has been made to systematically assess and quantify the actual contribution of engagement in milk production to improving household welfare and stimulating rural development. To strengthen the rationale underpinning dairy development for poverty reduction, this study aims to rigorously assess the available evidence for causal relationships between dairy (cattle & buffalo) development and improvement in human welfare.

APPROACH

In contrast to the traditional or narrative review, this paper evaluates the existing evidence of how and to what extent the impacts of dairying contribute poverty reduction and to improving socio-economic factors. In doing so it evaluates the quality and scientific rigour of that evidence, identifies the key conclusions that emerge from the literature, and assesses whether these conclusions are consistent across the sources.

APPROACH

Design of Study Review and Selection Process

A comprehensive review of the peer-reviewed and grey literature was conducted to identify studies providing quantitative information on the potential impacts of dairying on poverty reduction and socio-economic development. Databases searched included: IngentaConnect, Google Scholar, Repec, Web of Science and JSTOR. Search coverage was worldwide encompassing literature from 2000 onward. Multi-field searches were used with the search strings: 'dairy, poverty', 'milk production, poverty', 'cow, poverty', 'dairy, income', 'dairy, resilience', and 'dairy, economic impact'.

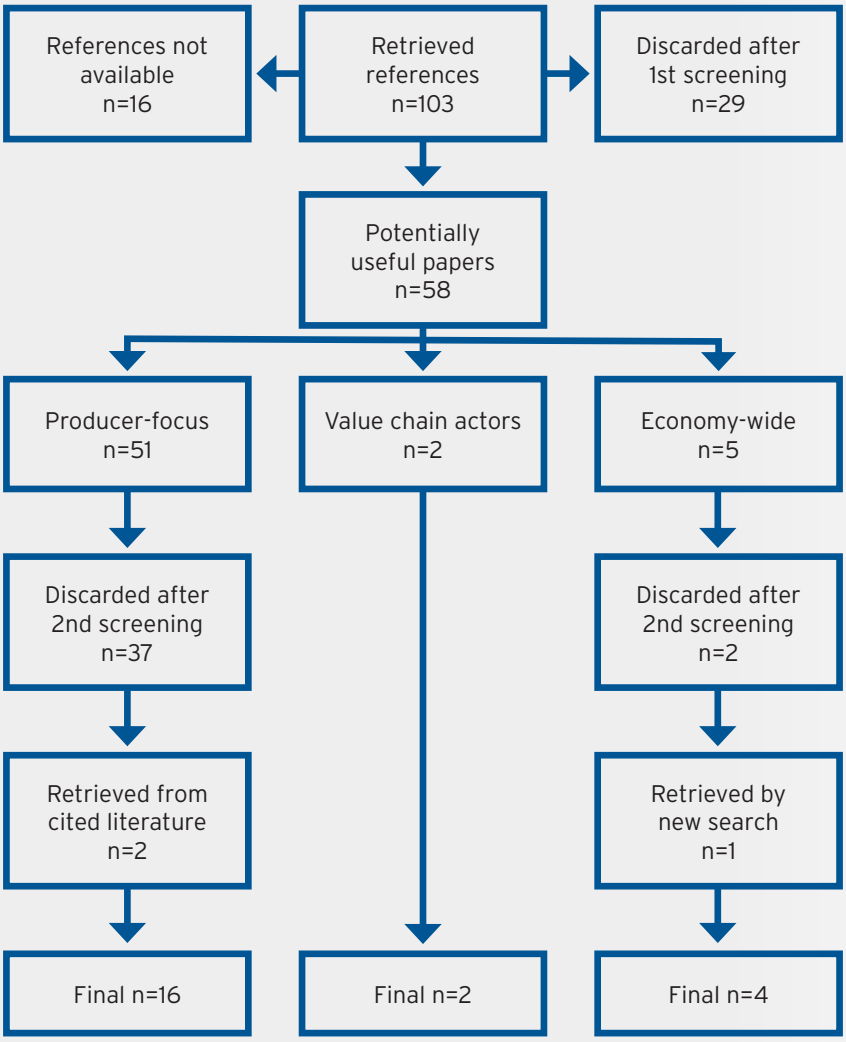
The database search resulted in a combined list of 103 references. Of these, 87 were obtained while 16, mainly book chapters, papers in journals of limited distribution (e.g. Kurukeshetra, Indian Cooperative Review) and meeting reports, could not be retrieved. As first step in the selection process, the abstracts of the available publications were scanned and papers not providing information related to the research question were discarded (29 papers). Of the remaining 58 papers, 53 covered household-related linkages between dairying and human welfare while 5 papers took an economy-wide approach using input-output relationships to estimate how milk production affects the broader economy. The vast majority of papers covering household-related aspects of dairying focused on producer households (51 out of 53) while only two papers, however covering four countries, dealt with employment generation in downstream value chains.

The key benefit of taking a quantitative study approach to assessing the impact of dairy on poverty alleviation is simple: it reduces the complex factors of socio-economics down to numbers that are easy to grasp and discuss.

The selection process is schematically represented in Fig. 1. The second step in the selection process consisted of an assessment of presence and quality of quantitative information presented in the papers. From the first group of papers, only papers reporting quantitative impacts of dairying on household welfare in 'treated' vs. 'control' groups (including before and after designs) combined with statistical analysis were included in the review of 'quantitative' assessments. Most papers in this group (37/51) did not fulfill the selection criteria and were thus discarded. For value chain papers, provision of quantitative information on direct and indirect employment generation per amount of milk handled was the only criteria for inclusion and both papers fulfilled this condition. Economy-wide assessments of dairy sectors all stemmed from the USA and Canada and thus do not necessarily reflect situations prevailing in lower / middle-income countries.

Nevertheless, this type of study provides valuable insights into broader economic/development impacts of the dairy sector and, for illustrative purposes, these studies were included in this review if they provided quantitative estimates of direct, indirect and induced effects on employment and value-addition, separated for raw milk production and processing segments of the dairy sector.

Figure 1: Schematic representation of selection of literature included in the review of quantitative evidence



Two papers cited in the studies retained after the second screening and three papers obtained through further searches were added to the final list of papers included in the review of quantitative evidence.

Box 1: Fostering Dairy Development in India: Operation Flood

In the 1950s and 1960s, **India faced severe milk shortages and relied heavily on milk imports.** Although milk has always been an important part of Indian diets and many Indian farmers, generally with a few cows only, produced milk, they were unable to satisfy the high and rising demand for milk of the nation's fast-growing cities.

This situation prompted the government of India to create the **National Dairy Development Board (NDDB)** in 1965 to direct India's dairy development. Earlier, milk producers in Anand district (state of Gujarat) had organized themselves into a private cooperative to supply milk to the Bombay Milk Scheme and their successful venture served as the model to be replicated throughout India.

In 1970, the government of India launched **Operation Flood (OF)**, a national-scale, federally sponsored intervention. OF replaced the ad hoc production, marketing, and selling of milk with an organized, continuous dairy-supply chain from production to consumption. It linked rural dairy producers to urban consumers through dairy cooperatives (providing extension, feed, health care, breeding services, and milk collection), chilling and processing plants, and distribution networks (refrigerated vans and railway wagons).

OF was scaled up in three phases

Phase I: 1970-1980
Targeted just four major urban markets, Mumbai, Kolkata, Delhi, and Chennai, and incorporated

1 million
rural milk producers

Phase II: 1981-1985
Enrolled another :

10 million
rural milk producers

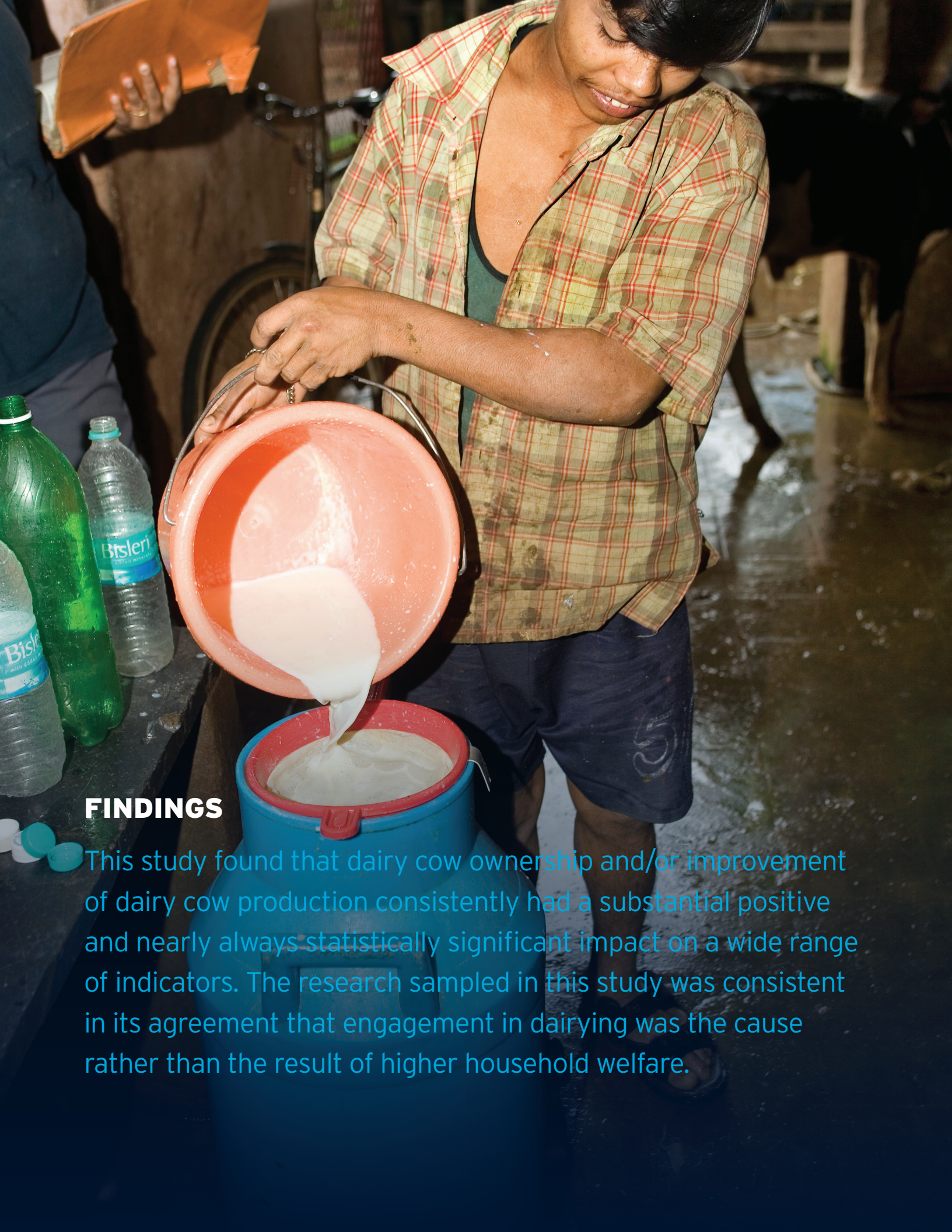
Phase III: 1986-1996
Consolidated and filled in the remaining gaps targeting close to

7 million
farmer families

All three stages were backed financially through international loans, donations of commodity aid, the Government of India, and internal programme resources.

OF undoubtedly created an enabling environment for dairy-sector development in India. Unfortunately, OF has not been the subject of independent meta-evaluations and micro-level impact studies suffer from small sample sizes and inconsistencies among research methodologies. Nevertheless, studies of OF showed that it effectively engaged the rural poor, that landless farmers' incomes increased after the organization of milk collection through cooperatives, that milk sales made a considerable contribution to income generation and that employment rates, including those of female workers, were higher among OF beneficiaries than among non-beneficiaries.

Cunningham K (2009) *Rural and Urban Linkages: Operation Flood's Role in India's Dairy Development*. IFPRI Discussion Paper 00924. Washington DC.



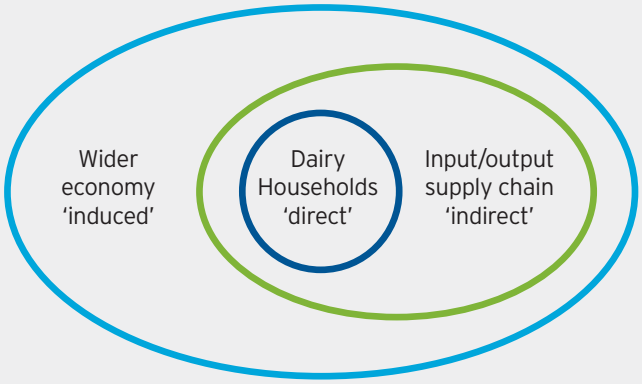
FINDINGS

This study found that dairy cow ownership and/or improvement of dairy cow production consistently had a substantial positive and nearly always statistically significant impact on a wide range of indicators. The research sampled in this study was consistent in its agreement that engagement in dairying was the cause rather than the result of higher household welfare.

Three Levels of Analysis Categories

As mentioned in the preceding section, the selected studies broadly fall into three strands of research. The first strand assesses the impacts of engaging in milk production on household welfare. The second strand of literature estimates employment generation in dairy value chains, while the third strand considers economy-wide impacts of the dairy sector (production and processing), which encompass 'direct' (producer), 'indirect' (value chains) and 'induced' impacts. The latter are the consequences of expenditure of income earned in the 'direct' and 'indirect' activities. The three levels of analysis and impact categories are represented in Fig. 2.

Figure 2: Diagrammatic representation of focus of analysis and type of impact



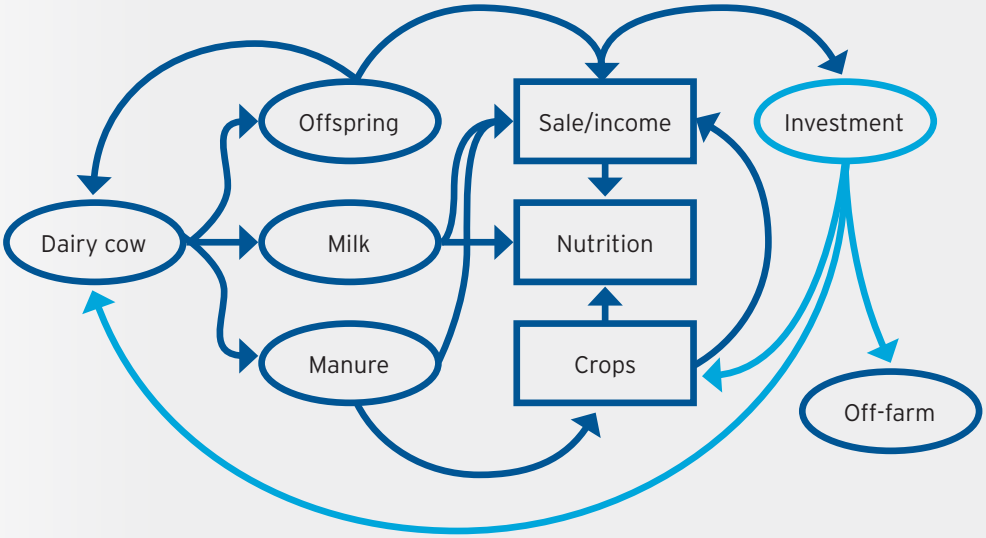
Dairy impacts on producer households

The bulk of the eligible studies cover the direct impact of engagement in milk production on household welfare. Two study designs are used to assess the impact of dairying on household welfare. The first draws on cross-sectional data and compares households with dairy cows (cross-bred or exotic) to households without dairy cows, in their majority controlling for numerous other variables potentially influencing household welfare. The second study design uses longitudinal data collected from households that have received a dairy cow (or two) through a donation programme and mostly compares household status before enrollment to status at various points in time after enrollment. In a few studies, welfare of households in a donation programme was compared to that of eligible households, which had so far not received an essential component of the programme. These two study designs were also used to assess the impacts of improved dairy cow management and / or participation in a dairy cooperative or 'dairy hub'.

A considerable number of measures are used to quantify various potential impacts of dairy cow ownership and improved dairy cow management on household welfare. The multitude of measures used reflects the variety of pathways through which dairy

cow ownership may affect household welfare (see Fig. 3). These pathways include (a) enhanced consumption of milk, (b) increased crop production through use of cow manure, (c) increased revenues from sales, all of which can enhance food security and nutrition, and (d) investment of additional revenues into farm and non-farm activities leading to 'multiplier' effects.

Figure 3: Impact pathways of dairy cow ownership on household welfare



Milk consumption and nutrition | Six studies assessed the impacts of dairy cow ownership on household nutrition (Summary of results in Table A.1). Ownership of dairy cattle consistently resulted in an increase in household milk consumption (from a low base). All studies report a substantial (33 to 900 percent) and in most cases statistically significant ($p<0.05$) or highly significant ($p<0.01$) increase in milk consumption (e.g. Jodlowski et al. 2016; Nicholson et al. 2005; Rawlins et al. 2013). Two studies (Jodlowski et al. 2016 and Rawlins et al. 2013) also assessed the impact of dairy cow ownership on total dietary composition. Both studies found a statistically significant increase in the number of food groups consumed over the past week. Rawlins et al. (2013) also found increases in height-for-age z-scores of about 0.5 standard deviations among children in households that received dairy cows.

Similar findings are reported from Ethiopia by Hoddinott et al. (2014), where cow ownership raised children's milk consumption, increased linear growth and reduced child stunting by seven to nine percentage points. These studies support the notion that livestock ownership in developing countries may significantly improve nutrition outcomes.

Crop yields | Only one study, Lewlamira et al. (2010), quantified the impact of dairy cow ownership on crop production (Table A.2). The observed increases in crop yields range from 96 percent for beans to 175 percent for bananas and are statistically highly significant. Bayer and Kapunda (2006) and Kayigema and Rugege (2014) also report greatly improved crop yields (>95 percent) as one of the consequences of dairy cow distribution in Tanzania and Rwanda respectively.

Gross household income | Increased availability of milk, as well as higher crop yields may improve household nutrition as well as enhance incomes. Six studies assessed the effect of dairy cow ownership on total income, either on *per capita* or household basis. The increase in total income attributable to dairy cow ownership ranged from 27 to 115 percent and was statistically significant at the 5 or 1 percent level in all cases, in which statistical analysis was performed (Table A.3). Mian et al. (2007), in Bangladesh, estimated the effect of dairy cow purchase on agricultural as well as on total income and found a larger impact on total income. This finding suggests returns on investment of dairy income into non-agricultural activities.

In addition to dairy cow ownership, enhanced performance and / or returns of dairy cows may result in improvements of household welfare. Three studies examined the income effect of enhancing dairy cow performance through improved management while another two compared the income of farmers participating in a dairy hub or cooperative to that of controls. The main benefit of participating in a dairy hub or cooperative was deemed to be access to inputs and management advice, i.e. ultimately also improved dairy cow management.

All five studies found that improved dairy cow management resulted in substantial (**46 to 600 percent**) and statistically significant increases in dairy income and, where assessed, also total household income (Table A.4). This finding highlights the large potential of contributing to rural development through dairy extension activities.

The investment of dairy income into other activities is likely to be one of the underlying reasons why the difference in total income attributable to dairy cattle ownership can be larger than the difference in agricultural or dairy income as reported by Mian et al. (2007) and Rao et al. (2015). Mian et al. (2007), for example, found that families, which purchased a dairy cow, increased their cultivated area by 39 percent.

Household expenditure | Rises in household income attributable to dairy do not take into account the additional costs associated with dairy cow ownership and milk production, and expenditure is often deemed a better measure of household welfare than income. Four studies examined the impact of dairy cow ownership on various classes of household expenditure (Table A.5).

Three of the four studies found **significant positive impacts on household food expenditure** while all four studies observed **significant positive impacts on non-food expenditures**.

Non-food expenditure comprises items such as clothing and school fees, but also the purchase of agricultural inputs such as improved seeds, renting or purchase of land and investment in non-agricultural activities (e.g. Ahmed et al. 2003, Mian et al. 2007, Tefurukwa 2011).

On-farm employment generation | Dairy cow ownership increases the demand for farm labour, which may be met by family members or by hiring labour. In the first case the additional labour input represents an opportunity cost while in the second it is an additional household expenditure. In situations of ample supply of farm / rural labour, on-farm employment generation may be regarded as an additional benefit of dairy production accruing to non-dairy households. Two studies quantified the additional labour requirements of dairy cow ownership met by salaried on-farm employment (Table A.6).

Both studies reveal significantly **higher employment generation by dairy farms** than by 'control' farms.

The results of Nicholson et al. (2004) furthermore suggest that farms with dairy cows, in addition to generating significantly more employment per cow than farms with local cows, also pay higher wages.

Dairy impacts through post- and pre-harvest employment generation

Although it is generally accepted that the dairy sector creates a substantial number of off-farm 'jobs', only two studies report quantitative information on employment generation in post-harvest dairy value chains.

Omore et al. (2005) provide information on the number of direct and indirect jobs created per 1000 l of traded milk in Bangladesh, Ghana and Kenya while Kumar et al. (2010) carried out a similar assessment in Assam, India (Table A.7). Across the four countries,

raw milk collection and distribution creates between 20 and 40 full-time jobs per 1 000 l of traded milk. In Assam, India, and Bangladesh, milk processing generates another 60 to 100 jobs per 1 000 l of processed milk with around 15 percent of traded milk being processed in Assam, leading to around 32 additional full-time jobs per 1 000 l marketed milk. After farm gate milk collection, milk processing, and marketing channels differ markedly between Ghana and Kenya (and between the latter and Bangladesh and India) and, as Omore et al. (2005) do not provide information on the proportion of milk passing through different channels, it is not possible to estimate the total number of jobs created per 1 000 l of milk collected at the farm gate.

The systematic literature search revealed that **quantitative information on employment generation in post-harvest dairy value chains is lacking**, making evaluation of this factor difficult.

Unfortunately, no study providing a quantitative estimate of employment generation in dairy farming input supply chains could be found. However, for Kenya, Muriuki et al. (2001) remark that marketing of forage (Napier, maize) is an important source of income in smallholder dairy production areas. A more recent study (Lukuyu et al. 2016) reports that fodder trading around urban and peri-urban areas is increasingly becoming an important source of fodder for dairy cattle in many developing countries.

Economy-wide assessments of impacts of dairy industries

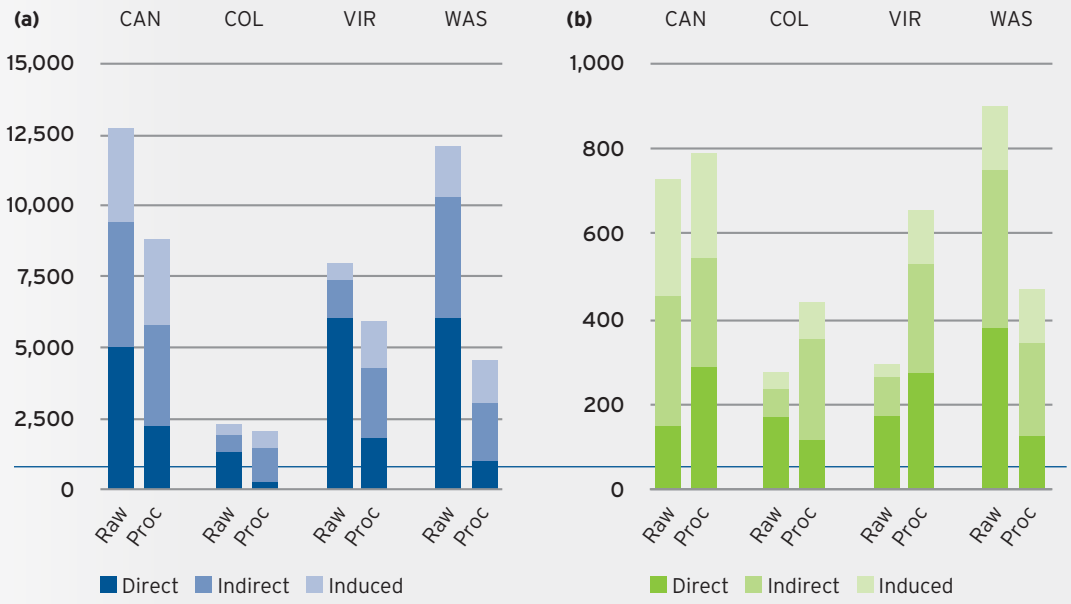
The studies reviewed in the preceding sections provide useful accounts of the impacts of dairying at household level but they do not provide information on the aggregate socio-economic impact of dairy development within a country or region. Unfortunately, eligible assessments of the economy-wide impacts of dairy industries (direct, indirect and induced impacts of the raw and processed milk sub-sectors) could only be found for Canada and some states of the USA. Despite this limitation, a brief overview of some salient examples of economy-wide assessments of the impacts of dairy industries is deemed relevant as they illustrate the catalytic function of dairy development on other sectors of the economy and the potential shortfalls of assessments limited to impacts on producer households.

Formal economy-wide assessments of the economic impacts of dairy sectors suggest that the **indirect and induced impacts are at least as large, if not larger than the direct impacts**.

FINDINGS

Fig. 4a provides an overview of direct, indirect and induced employment generation of milk production and milk processing for Canada and individual states of the USA (details in Table A.8). In Canada for instance, the dairy sector generates some 215 thousand jobs (125 000 in raw milk and 80 000 in processed milk), of which less than a quarter (51 000) are on dairy farms. For raw milk production, employment multipliers, i.e. the ratios of total employment over direct employment, ranging from 1.3 (Virginia) to 2.5 (Canada), indicate that 0.3 to 1.5 non-dairy farm jobs are created for every dairy farm job. For the processing sub-sector, overall employment is lower, but multipliers are higher, ranging from 3.3 (Virginia) to 6.6 (Colorado) in the available examples.

Figure 4: Direct, indirect and induced employment[1] (a) and value-added[2] (b) impacts of raw milk production and milk processing in Canada (CAN)[3], Colorado (COL), Virginia (VIR) and Washington (WAS)



[1] Full-time jobs, [2] million $, [3] for Canada scales need to be multiplied by 10

Estimates of direct, indirect and induced value-added of the raw milk and milk processing sub-sectors for Canada and selected states of the USA are presented in Fig. 4b (details in Table A.9). The processing sub-sector generates more value-added than the raw milk sub-sector in three of the four examples. Similar to employment multipliers, value-added multipliers tend to be larger in milk processing than in raw milk production.

Although these assessments reflect circumstances of 'developed' dairy sectors in two high-income countries, the key finding, that dairy farming results in substantial

employment generation and value-addition beyond the farm gate, which in turn spurs development and poverty reduction, is also relevant for less developed dairy industries. The magnitude, however, remains largely unquantified. An indication of the potential magnitude of employment generation by a vibrant dairy industry is provided by an assessment of the Kenyan dairy industry (USAID 2014). The authors estimate that for every on-farm dairy job an additional 1.3 jobs are created in the processing and service sectors for a total of 2.25 million jobs generated by the entire Kenyan dairy industry in 2012. This would represent employment for around 13.5 percent of the country's labour force (16.7 million in 2012).

The reviewed literature provides strong evidence that in specific settings **dairy development makes a significant contribution to poverty reduction**, both at household and community level.

Complementary information to estimate the number of dairy farms by region

Table 1 Estimated number of dairy farms

Country groups	N of cattle and buffalo farms	% of cattle/buffalo farms keeping dairy animals	N of dairy farms
East Asia and the Pacific	50.5	5.7%	2.9
Europe and Central Asia	18.5	87.7%	16.2
High-income	3.8	25.9%	1.0
Latin America and the Caribbean	7.8	37.2%	2.9
Middle East and North Africa	4.5	67.7%	3.0
South Asia	89.0	81.5%	72.6
Sub-Saharan Africa	16.7	77.9%	13.0
World	190.7		111.6

Source: Mele A., K. Reincke, T. Hemme, O. Mikecz, U. Pica-Ciamarra and E. Reyes (2018) *The Number of Dairy Farms Worldwide*. IFCN and FAO, 2018.

The number of dairy farms worldwide

FAO and IFCN (2018) estimate that globally there are about 112 million dairy farms keeping cattle and/or buffalo. Sixty-five percent of these, that is 73 million farms, are located in South Asia. Eastern Europe and Central Asia and Sub-Saharan Africa follow with an estimated 16 and 13 million dairy farms respectively. In each of the remaining world regions, which comprise high-income countries, the Middle East and North Africa, and East Asia and the Pacific, there are between 1 and 3 million dairy farms. Globally, the average dairy herd consists of three adult female cattle/buffalo with large regional differences. In South Asia, the average dairy herd size is less than two dairy animal. In sub-Saharan Africa, North Africa and the Middle East, and Eastern Europe and Central Asia it is between 2 and 4 animals. In East Asia and the Pacific, a typical dairy farm raises about 9 dairy animals while in Latin America and the Caribbean this number rises to 15 and to over 42 in high-income countries.

FAO and IFCN estimates on the number of dairy farms rely upon official statistics from 57 countries assembled by FAO's World Programme for the Census of Agriculture and by IFCN. For these countries statistics were available both on the number of cattle/buffalo farms and the number of dairy farms. To generate an estimate of the number of dairy farms by region and for the world, FAO and IFCN calculated the regional shares of cattle and buffalo farms keeping dairy animals in the 57 sample countries, representing 28 and 72 percent of all world's countries and rural populations respectively, and applied these shares to the number of cattle/buffalo farms from Census data for countries lacking information on the number of dairy farms. The year of reference varied by country and is that of the most recent Census of Agriculture.

DISCUSSION

At the highest level, this study shows that dairy has a role to play in poverty alleviation. Dairying not only contributes a regular source of food and income, but it puts farmers in a better position to feed their families, send their children to school, provide for their family's health, and invest in their future.

DISCUSSION

A large body of literature promotes dairy development as promising avenue for poverty reduction (e.g. FAO 2010; Staal et al. 2008a; Staal et al. 2008b) but does not provide conclusive evidence of a causal relationship (i.e. are farmers better off because they have dairy cows or are better-off farmers more likely to engage in dairying?). Thus, to strengthen the case for dairy development as an avenue for poverty reduction, the prime objective of this review of the literature was to compile and assess the evidence for a causal relationship between dairy development and poverty reduction / improved household welfare.

For causal inference, randomized controlled trials (RCTs) are considered the gold standard of experimental design (Victoria et al. 2004). In RCTs, study units are randomly allocated to 'treatment' and 'control' groups, which minimizes selection and information bias, controls confounding[1], and rules out chance. However, causal chains in development interventions are long and complex, making RCT results subject to effect modification[2] in different populations and often inappropriate for the scientific assessment of the performance and impact of large-scale interventions (idem). Victoria et al. (2004) argue that the validity of RCT findings can be greatly enhanced by observational studies using 'plausibility' designs, i.e. studies demonstrating that the foreseen changes / differences were of sufficient magnitude, in the expected direction and occurred in a temporal sequence consistent with the hypothesized impact. For evaluating large-scale interventions, studies with plausibility designs are often the only feasible option and may provide valid evidence of impact (idem).

To maximise the validity of causal inference, only RCT studies and observational studies with a comparison group, in their vast majority rigorously controlling for confounding were included in the group of studies used for the quantitative assessment of the impact of dairying on household welfare. Application of these selection criteria severely restricted the number of studies included in the analysis.

Across all studies, dairy cow ownership and/ or improvement of dairy cow production consistently had a substantial positive and nearly always statistically **significant impact on a wide range of indicators used by different researchers**.

These results and their consistency across study types, countries and indicators provide strong evidence that engagement in dairying was the cause rather than the result of higher household welfare (in the studied settings).

[1]Confounding occurs when the effect or association between the 'treatment' (or exposure) and outcome is distorted by the presence of another variable.

[2]Effect modification is a phenomenon in which the 'treatment' (or exposure) has a different impact in different circumstances.

This finding is in accordance with the results of a rigorous assessment of randomized control trials of an integrated approach to improve livelihoods among the very poor by Banerjee et al. (2015). The approach combines the transfer of a productive asset, in most cases livestock, with other forms of support. The same basic programme, adapted to a wide variety of geographic and institutional contexts and with multiple implementing partners, led to statistically significant cost-effective impacts on consumption (fuelled mostly by increases in self-employment income) of the targeted households.

Both, Banerjee et al. (2015) as well as the assessments of the impact of providing a household with a dairy cow / pregnant heifer emphasize the necessity of observing minimum eligibility requirements and provision of complementary support, of which training is an essential element. Owning a small piece of land and being able to provide an animal shed are common prerequisites for dairy cattle transfer programmes implying the poorest households tend to be ineligible. Squicciarini et al. (2016) in their assessment of the impact of dairy cow ownership in India also found that land ownership, even if only a small piece, was a significant determinant for engaging in dairy production. In fact, small stock (sheep, goats, chicken) were the most common productive assets chosen in the programmes to improve livelihoods among the very poor analysed by Banerjee et al. (2015). The importance of training in dairy cattle transfer programmes was clearly demonstrated by Argent et al. (2014) in Rwanda.

One of the shortcomings in the assessments of the impact of dairy cow transfer programmes is the usually relatively short follow-up period (in most cases <2 years). This limitation weakens conclusions about the longer-term sustainability of the measured impact. However, Bayer and Kapunda (2006) evaluated a dairy cattle transfer programme in Tanzania five to six years after its inception.

> The evaluation found "that **families that barely managed to survive six years ago are now considered wealthy**. After 3–4 years, some farmers saved enough to improve their houses, to increase their land area under crops, and to send their children to secondary school (some farmers even send their children now to more expensive private schools)."

Banerjee et al. (2015) also report that the impact on the poor households lasted at least a year after all implementation ended. Further evidence of a lasting improvement of household welfare associated with dairy cow ownership is provided by the large-scale cross-sectional assessments using quasi-RCT study designs as the majority of surveyed farmers with dairy cattle are unlikely to have been recent entrants into the sector.

DISCUSSION

An important question associated with the transfer of a dairy cow is how its impact on household welfare compares to the transfer of other livestock species, other productive assets or cash of equivalent value. The studies of Rawlins et al. (2013) and Kafle et al. (2016) also assessed the impacts of the transfer of 5 meat goats to rural households in Rwanda and Zambia respectively. Both studies found that the transfer of dairy cows had larger impacts on household nutrition than the goat transfers. Using the same data as Kafle et al. (2016), Jodlowski et al. (2016) estimated the required returns of a cash gift of equivalent value to meet the impact on household dietary diversity of a donation of dairy cattle, draught cattle, and goats. The required returns were estimated as 133% for dairy cattle, 88% for goats and 8% for draught cattle.

Another important question about the potential of dairy development to serve as engine for wider rural development and poverty reduction relates to its scalability as not all farmers in any one village or region can become dairy farmers. However, this is the case for specialisation in any type of livestock production or related income-generating activity and spill-over, as well as second round effects also need to be considered.

Dairy farming appears to have multiple and substantial spill-over effects. At community-level, Jodlowski et al. (2016) found that the distribution of dairy cows also led to a statistically significant increase in milk consumption of households that did not receive an animal because availability and affordability of milk had increased.

In Tanzania, Bayer and Kapunda (2006) observed that some farmers who had received dairy cows dug wells to ease the work of obtaining water mainly for the cattle but also for other animals and people and that neighbours were also using these wells. The dairy value chain studies carried out in four countries show that milk collection and distribution generates a considerable amount of direct and indirect employment while employment generation by processing and retail depends on the dominant product types. Formal economy-wide assessments of the economic impacts of dairy sectors, although not available for developing countries, suggest that the indirect and induced impacts are at least as large, if not larger than the direct impacts.

An additional benefit of dairy development programmes observed in several of the reviewed studies and quantified by Mian et al. (2007) is the increased involvement of women in household decision-making. This effect directly contributes to SDG5, achieve gender equality and empower women and girls, and is highly likely to indirectly also have positive effects on SDG2 (e.g. Jin and Iannotti 2014) and SDG 1.

The majority of the reviewed studies on the impact of dairy cattle on household welfare have been carried out in East Africa, a region renowned for smallholder dairy production, particularly in its more temperate zones, and mostly in locations in proximity to sizeable markets. Extrapolation of the findings to other settings may, therefore, be problematic. A complete assessment of the aggregate poverty reduction potential of dairy sector development at sub-national, national or regional scale would require estimates of eligible low-income households, anticipation of production and marketing structures (including services) and demand projections.

Women empowered by dairy farming have **increased income and influence over household expenditures**, which boosts their social and economic capital.

CONCLUSION

Dairy has the power to provide a major pathway out of poverty for individuals, families, and communities by making the necessities of life– food, water, shelter and clothing – accessible and affordable.

CONCLUSION

Despite the limited number of studies, diversity of study types and heterogeneity of impact indicators, the reviewed literature on the economic impacts of dairying on household and community welfare provides strong evidence that in specific settings dairy development makes a significant contribution to poverty reduction, both at household and aggregate community level.

Prerequisites for dairy cattle to sustainably improve household welfare are that (a) households fulfill minimum requirements with regards to land ownership and labour supply and that (b) they receive a minimum amount of support in terms of training, input provision and disease control.

Provision of market access further **enhances the development potential of dairying** as it stimulates the growth of up- and downstream businesses and provides producer households with proceeds that can be invested in other farm and non-farm enterprises. **These indirect effects substantially enhance the direct benefits accruing to dairy households**.

RECOMMENDATIONS

Dairy has the power to be a major pathway out of poverty as investments in the sector generate positive returns to reduce poverty and contribute to SDG1. However, improving our capacity to assess the contribution of the dairy sector to poverty reduction is necessary for designing and implementing investments that are genuinely pro-poor, and sustainable from a social, environmental and public health perspective.

For Research | The studies reviewed in this document rarely used any conceptual/analytical framework of the pathways linking dairying to poverty reduction; rather they describe or quantify certain elements in an isolated manner. Consequently, a wide range of impact indicators was used, complicating cross-study comparisons. The lack of a conceptual framework is probably also the reason for the relative neglect of some impact pathways, e.g. enhancement of crop yields through the application of cattle manure.

Development and use of a common conceptual framework for better understanding the inter-linkages between dairying and household or community welfare combined with a set of agreed impact indicators would significantly enhance the utility of future research endeavours.

Most research on dairy development is limited to on-farm impacts and very few studies explore socio-economic effects of dairy development on actors in dairy value chains. More comprehensive sector-wide studies are required for a fuller understanding of the potential contribution of dairy development to SDG1.

A fuller understanding of the potential contribution of dairy development to eradicate poverty in all its forms **requires a consistent methodology be developed and applied at global, regional, national and local level.**

For Development | To fully attain its poverty reduction potential, dairy development initiatives should adopt a systems approach that takes into consideration that multiple technical, social and institutional constraints that make it challenging for actors along the value chain to tap into the multiple benefits the dairy sector offers.

Given the diversity and technical as well as institutional complexities of dairy supply chains, dairy development strategies need to be carefully tailored to specific contexts and must consider efficiency and competitiveness of all dairy chain actors, targeting dairy farmers, input and service suppliers, milk traders, processors, retailers, consumers and other actors (FAO 2010).

To ensure dairy development strategies maximise the potential contribution of the dairy sector to poverty reduction, indicators for measuring specific progress towards SDG1 in the dairy sector should be agreed upon at global, regional and local level, and be closely aligned with the larger indicator framework for measurement of progress towards the SDGs being developed by the international community.

To ensure dairy development strategies fully support the achievement of SDG1, a system of global, regional, national and local sector indicators should be agreed upon that is aligned with the larger SDG1 indicator framework.

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ANNEXES

ANNEX 1: SUMMARY TABULATIONS OF STUDY RESULTS

Table A.1 Impact of dairy cow (DC) ownership on food consumption

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Ahmed et al. 2003	DC	No DC	Energy intake (cal/day)	2,511	2,177	15**
			Protein intake (g/day)	76	67	13**
Jodlowski et al. 2016	DC	Before	Days/week consuming additional food group	Plus 4.5		65***
			Value of additional hh milk consumption/week (USD)	Plus 4.8 (≈10l)		≈900***
Kabunga 2014	DC	No DC	Milk consumption/hh/year (l)	51	29	76*
Nicholson et al. 2004	DC	No DC, no cow	Additional milk equivalent consumption pc/week (l)	Plus 1.0-1.4/cow		33*/ 53***
Rawlins et al. 2013	DC	No DC	Additional food groups consumed in the past 2 days (average=7.79)	Plus 1.17		15-20***
			Additional milk consumption pc/month (l) (average=3.6l)	Plus 9.3-10.9		260-300***
Tefurukwa 2011	DC	Before	Milk consumption/hh/day (l)	1.31	0.37	254[nc]

*p<0.1 **p<0.05 ***p<0.01 [nc]not calculated

Table A.2 Impact of dairy cow ownership on crop yields

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Lwelamira et al. 2010	DC	No DC	Banana yield (bunches/acre)	314	114	175***
			Bean yield (kg/acre)	231	118	96***
			Maize yield (kg/acre)	152	63	141***

***p<0.01

Table A.3 Impact of dairy cow ownership on (gross) income

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Ahmed et al. 2003	DC	No DC	Annual total pc income (ETH Birr)	1,663	1,178	41**
Lwelamira et al. 2010	DC	No DC	Annual total income (million TSh)	2.6	1.4	86***
Mian et al. 2007	DC	Before	Annual agric. hh income (BGD Taka)	16,107	10,113	59[nc]
			Annual total hh income (BGD Taka)	32,228	17,219	87[nc]
Nicholson et al. 2004	DC	No-DC, no cow	Increase in total hh income per dairy cow/ month (KSh)	Plus 2,115 – 3,488		53***/ 87***
Squicciarini et al. 2017	DC	No-DC, no cow	Increase in total pc income			27**/ 31***
Tefurukwa 2011	DC	No DC	Annual total hh income (thousand TSh)	1,012	524	93**
		Before	Annual total hh income (thousand TSh)	1,012	471	115**

** p<0.05; *** p<0.01; nc not calculated

Table A.4 Impact of improved dairy cow production on (gross) income

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Argent et al. 2014	IM	No IM	Increased income from milk production/day (USD)	Plus 0.82		66**
Bayemi et al. 2009	IM	Before	Net income/cow/month (USD)	54.0	36.9	46[nc]
Mian et al. 2007	DC	Before	Annual agric. hh income (BGD Taka)	16,107	10,113	59[nc]
			Annual total hh income (BGD Taka)	32,228	17,219	87[nc]
Kidoido & Korir 2015	IM	No IM	Dairy income: low income hh			99*
			Dairy income: high income hh			603***
Rao et al. 2015	Dairy hub	No hub	Annual dairy income (USD)	1,387	365	280***
			Annual total hh income (USD)	10,007	5,379	86**
Alemu & Adesina 2015	Coop	No coop	Dairy income			73***
			Total hh income			51***

[1] IM = Improved management; * p<0.1 ** p<0.05; *** p<0.01; [nc] not calculated

ANNEX 1: SUMMARY TABULATIONS OF STUDY RESULTS

Table A.5 Impact of dairy cow ownership on household expenditures

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Ahmed et al. 2003	DC	No DC	Cash expenditure on food (ETH Birr)	168	151	11^{ns}
			Cash expenditure on non-food (ETH Birr)	178	159	12^{ns}
			Hh expenditure on farm inputs (ETH Birr)	1,382	988	40***
Kabunga 2014	DC	No DC	Food poverty (% hhs)	0.15	0.25	-40**
			Non-food poverty (% hhs)	0.30	0.44	-32**
Kafle et al. 2016	DC	Before	Food expenditure after 18 mo (USD/pc/day)	0.65	0.51	28**
			Consumption expendi-ture after 18 mo (USD/pc/day)	1.15	0.96	20**
Mian et al. 2007	DC	Before	Annual hh food expenditure (BGD Taka)	7,542	4,987	51**
			Annual hh total expenditure (BGD Taka)	28,521	19,498	46**

** p<0.05; *** p<0.01; nc not calculated

Table A.6 Impact of dairy cow ownership on hired farm labour

Study	Treat.	Control	Outcome	Treat.	Control	% Diff
Muriuki et al. 2001	DC	No-DC, No cow	Casual labour (% hhs)	50	35	43**
			Permanent labour (% hhs)	20	1	1900**
Nicholson et al. 2004	DC	Local cow	Hired cattle labour/cow (hrs/week)	6.5	1.8	260***
			Monthly salary payments (KSh)	1,163	164	609***

* p<0.1 ** p<0.05; *** p<0.01

Table A.7 Post-harvest employment generated per 1 000 l traded / handled milk by type of

Country	Enterprise type	Averare milk/day	Jobs created/1000 1 handled		
			Direct	Indirect	Total
Assam, India	Milk trader1	75			19.5
	Processor	52*			57.8
	Both	87			
	Total				31.8
Bangladesh	Milk trader2	102	15	29	44
	Broker3	9,620	0.2	0	0.2
	Processor	74	56	44	100
Ghana	Assembler	200	20	14	34
	Retailer	20	100	0	100
	Processor	150	17	21	38
Kenya	Milk trader	86	17	3	20
	Milk bar	107	11	3	14
	Processor	100-2,500	2	1	3

[1]Dudhia, [2]Gowala, [3]Aratdar, * app. 15% of traded milk is processed
Source: Assam, India – Kumar *et al.* 2010; Bangladesh, Ghana and Kenya–Omore *et al.* 2005

Table A.8 Direct, indirect and induced employment generation by milk production and processing sectors in Canada and selected states of the USA

Study	State		Jobs generated				Multi-plier
		Country	Direct	Indirect	Induced	Total	
Jaques et al. 2011	Canada	Raw milk	50,754	43,863	32,746	127,363	2.5
	Canada	Proc. milk	22,672	35,162	29,907	87,741	3.9
Neibergs & Brady 2013	Washington	Raw milk	6,184	4,221	1,754	12,159	2.0
	Washington	Proc. milk	1,012	2,047	1,438	4,497	4.4
Rephann 2015	Virginia	Raw milk	6,071	1,485	366	7,922	1.3
	Virginia	Proc. milk	1,804	2,532	1,561	5,897	3.3
Jaques et al. 2011	Colorado	Raw milk	1,238	631	402	2,271	1.8
	Colorado	Proc. milk	314	1,159	590	2,063	6.6

ANNEX 1: SUMMARY TABULATIONS OF STUDY RESULTS

Table A.9 Direct, indirect and induced value-addition by milk production and processing sectors in Canada and selected states of the USA

Study	State		Value-added (million $1)				Multi-plier
		Country	Direct	Indirect	Induced	Total	
Jaques et al. 2011	Canada	Raw milk	1,519	3,066	2,673	7,258	4.8
	Canada	Proc. milk	2,905	2,556	2,465	7,926	2.7
Neibergs & Brady 2013	Washington	Raw milk	389	359	148	895	2.3
	Washington	Proc. milk	135	215	121	471	3.5
Rephann 2015	Virginia	Raw milk	179	88	30	297	1.7
	Virginia	Proc. milk	272	258	126	657	2.4
Swanepoel 2014	Colorado	Raw milk	180	61	38	279	1.6
	Colorado	Proc. milk	122	236	88	446	3.6

ANNEX 2: SUMMARIES OF STUDIES USED FOR QUANTITATIVE ASSESSMENTS

Dairy cow impacts on producer households

Ahmed et al. 2003 | Highlands of Ethiopia

A recursive empirical analysis was applied based upon a detailed survey of 57 and 90 households in 1997 and 1999, respectively, in the Holetta area in the highlands of Ethiopia. **The results of the analysis indicate that adoption of crossbred cows and complementary feed and management technologies along with crop area, labour supply and use of inputs is a significant determinant of per capita income**. Variability of expenditure on purchased food is explained by household income, area allocated to food crops, proportion of cash income in total income, distance to the nearest crop market as well as socio-economic characteristics of the household. Household income and proportion of cash income principally determined expenditures on non-food and farm and livestock inputs. Cash expenditure on food, and the unit price of nutrient are important determinants of per capita calorie, protein and iron intakes. Furthermore, household demographic characteristics such as gender of the head of the household and age of the mother play a significant role in the nutrient composition of consumed food. **The results indicate that market-oriented activities moderately reduce poverty and improve food security and nutrition of smallholder households. Through its impact on the expenditure of inputs, market-oriented dairy production may also lead to increased intensification of crop production and further improves incomes and nutrition**. Agricultural development strategy of the country should take this option into consideration. Moreover, such introduction has the potential of stimulating the rural economy through the increased demand for non-food. Success of such activity depends on availability of marketing infrastructure to encourage smallholders' market participation.

Alemu and Adesina 2015 | Northern Ethiopia

Farmer-induced collective action (co-operatives) or buyer-driven contracts are often in place in global agrifood chains. Their economic contribution is well recognised, although the exclusion of smallholders remains. This paper pays particular attention to the impact of co-operatives and contracts on dairy production and the income of dairy farmers in the local food chains in Northern Ethiopia. A structured survey of 415 dairy farmers was undertaken in four districts of Northern Ethiopia. Propensity score matching, regression on observables and regression on propensity scores were implemented to control selection bias. **Both models yielded consistent treatment effect estimates, implying that milk production, cow productivity and household income for the members of co-operatives are larger in contrast to dairy farmers employing the spot market**. We suggest that strengthening co-operatives may enhance and upgrade the dairy sector.

ANNEX 2: SUMMARIES OF STUDIES USED FOR QUANTITATIVE ASSESSMENTS

Argent et al. 2014 | Rwanda

We present evidence from Rwanda's Girinka ('One Cow per Poor Family) program that has distributed more than 130,000 livestock asset transfers in the form of cows to the rural poor since 2006. Supply side constraints on the program resulted in some beneficiaries receiving complementary training with the cow transfer, and other households not receiving such training with their cow. We exploit these differences to estimate the impact of receiving complementary training with the cow transfer, on household's economic outcomes up to six years after having received the livestock asset transfer**. Our results show that even in a setting such as rural Rwanda where linkages between farmers and produce markets are weak, the provision of training with asset transfers has permanent and economically significant impacts on milk production, milk yields from livestock, household earnings and asset accumulation**. The results have important implications for the design of 'ultra-poor' livestock asset transfer programs being trialled globally as a means to allow the rural poor to better their economic lives.

Bayemi et al. 2009 | Cameroon

A study was carried out to evaluate the impact of interventions to solve constraints in smallholder dairy farms of the Western Highlands of Cameroon. The interventions consisted of improved breeding through introduction of artificial insemination, better feed supplementation, farmers training in milk processing and better veterinary services. Results show that there was a decrease in average monthly expenditures of 18% relative to the month before interventions started. Much of the expenditures were related to feed (38% of all costs). There was an overall increase in farm income. Close to 2/3 of the income were derived from milk products from home processed milk and culled animals. Only 7% income came from milk sold to the processing plant. The partial budget shows that before interventions, farmers lost $4.5/cow/month but gained $38/cow/month because of the interventions. The return was 2.32 and included opportunity income for milk home consumed and shared. **When this opportunity income was ignored, the return stood at 1.93. The positive impact of interventions led to poverty alleviation and some farmers acquired more cows. A spill over effect is that more crop farmers are willing to be engaged at least partially in dairy farming. It will be good if many more farmers could benefit from these interventions**.

Jodlowski et al. 2016 | Zambia

Smallholder livestock ownership has potential to enhance food security by raising incomes of the poor and by increasing the availability of nutrient-dense foods. This paper exploits the staggered rollout of livestock distribution by Heifer International in Zambia to identify the effects of livestock using statistically similar treatment and control groups in a balanced panel of households. **Results indicate that livestock ownership improves dietary diversity through both direct consumption of animal products**

produced on farm and through increased consumption expenditures. Further results indicate that expanded livestock ownership alters the local food economy to influence food consumption by households lacking farm animals.

Kabunga 2014 | Uganda

There is limited empirical evidence on the linkages between agro-technologies, poverty reduction and the pathways to better nutrition outcomes. The introduction and dissemination of improved dairy cow breeds in Uganda is arguably the most significant step taken to develop a modern and commercial dairy industry in the country over the last two decades. This study uses a nationally representative sample of Ugandan households to rigorously examine the impact of adoption of improved dairy cow breeds on enterprise-, household-, and individual child-level nutrition outcomes. **We find that adopting improved dairy cows significantly increases milk productivity, milk commercialization, and food expenditure. Consequently, adoption substantially reduces household poverty and stunting for children younger than age five. These results are consistent with the perceived role of new agro-technologies. Considering heterogeneity in farm size, we find that households with small farms will increase milk yield and food expenditure while also reducing poverty substantially due to adoption, and large farms increase not only own-milk consumption and commercialization but also nutrition outcomes of children younger than age five**. This suggests that the nutritional benefits of adoption may not sufficiently help reduce child malnutrition for young children living on small farms. We argue that for holistic and sustainable improvements in broader welfare and nutrition outcomes, agricultural development programs should be accompanied with related programs on gender empowerment, nutrition education, and food safety and hygiene.

Kafle et al. 2016 | Zambia

Analyses of the impacts of asset transfer programs often find statistically significant effects on consumption expenditures that are large in percentage terms but small in absolute value. This study explores the practical significance of such impacts using the case of a livestock transfer program among impoverished households in Zambia. As in other studies, results show that the asset transfers increased household consumption expenditure and dietary diversity. Extending previous work, this paper examines whether the increase in expenditures has been large enough to trigger changes in consumption patterns or in subjective assessment of poverty status. Changes in composition of expenditures, composition of diet, and subjective self-assessment of poverty all suggest a growing sense of security and a practically significant change in welfare for treated households. As transfers included three different types of animals – dairy cows, meat goats, and draft cattle – we are able to discern that the specific nature of the asset transferred influences food security impacts. Examination of change in the composition

of consumption shows substantial effects on poverty and food security starting within six months of livestock transfers. **Persistence of the impact through the next 18 months of our study period indicates that livestock transfers can have a sustained effect on poverty and food security**.

Kidoido and Korir 2015 | Zambia

This study investigated the differences across income strata in contributions of dairy innovations and dairy production to dairy income and nutrition outcomes. Although dairy innovations had a positive effect on dairy income, the effect was small among low-income households due to their lack of comparative advantage in accessing and using inputs, output markets and services. Also, their reliance on low productivity dairy animals affected their potential dairy income. Consumption of dairy products in low-income households was associated with reduced stunting, underweight and wasting. Wasting in high-income households was only significant among girls. **Whereas adoption of dairy innovations and consumption of dairy products have great potential for improving the income and nutrition of low-income households, pro-poor dairy interventions should also be integrated with increasing access to markets and services**. Interventions should also incorporate strong gender aware approaches to ensure that the benefits are shared equitably within households.

Lwelamira et al. 2010 | Tanzania

This study was carried in Kayanga ward, Karagwe district in Tanzania with the aim of evaluating contribution of small-scale dairy farming in improving household welfare. **Results from this study indicated that small-scale dairy farming contributed substantially to household welfare**. Average annual profit per household from small-scale dairy farming was on the same range as those from crop production and small-scale business (i.e. approximately 1 million Tsh) meaning that it is equally profitable as with other main enterprises by dairy farmers. As a result of using manure in farms from dairy cattle, average food crop yields among small-scale dairy farming households were significantly higher ($p<0.01$) than those of non-dairy farming households and hence more food secure. Average household income, value of durable assets, and food security status (frequency of consumption of some nutritious food) were significantly higher ($p<0.01$) in dairy farming households than in non-dairy farming households indicating dairy farming households to be better-off than their counterparts.

Mian et al. 2007 | Bangladesh

Data were collected from six villages, namely, Kutobpur, Sangrampur, Srirampur, Uttar Imadpur, Bara Hazratpur and Chhoto Hazratpur under Mithapukur Upazila of Rangpur district. The basic criterion for selecting the sample was that a respondent must at least possess one dairy cow, which she bought by the credit from Grameen Bank. The selection

of the respondents was made randomly from among those who fulfilled this criterion. Increase in income from dairy sector was the highest. Increased income from agricultural activities was the second highest. **In general the average per family total income increased by 87.5 per cent**. All the livestock and poultry resources were reported to have increased after becoming members of the GB. Three indicators namely food, clothing and social activities related with expenditure pattern were used to highlight the change of socio-economic status of the families. **It is observed that after involvement with GB overall food consumption per family increased by 42.9 per cent**. It is also observed that because of member participation and newly generated income from dairy raising the respondents were able to increase their expenditure on clothing, which was 51.4 per cent. **The overall expenditure in social activities increased by 59.5 per cent and agricultural expenditure increased by 51.2 per cent**.

Muriuki et al. 2001 | Kenya

By taking a holistic production-to-consumption approach and carrying out systematic analyses of Kenya's dairy sub-sector, the Smallholder Dairy (R&D) Project and the related research has shown that dairying is a very significant source of income and food for an estimated 625,000 smallholder producer households. Many of these farm households would not have been able to sustain their families without the benefits accruing from dairying and its interactions with crop production. In the same way, the employees of the smallholder dairy producers, the input suppliers and those involved in the marketing of milk have benefited significantly from dairying, in total approximately 25% of all households in rural Kenya. **Therefore not only has smallholder dairying made a major contribution in Kenya to food security and poverty alleviation, but in the face of the continuing pressure on land and the resultant intensification of land use systems, it is expected to continue to do so for many years to come, particularly if it is given targeted R&D support by efforts like SDP**.

Nicholson et al. 2004 | Kenya

This study uses heteroskedastic Tobit and Censored Least Absolute Deviations models to examine the impacts of dairy cow ownership on selected outcomes for a sample of 184 households in coastal Kenya. The outcomes examined include gross household cash income, gross non-agricultural income, consumption of dairy products, time allocated to cattle related tasks, number of labourers hired and total wage payments to hired labourers. **The number of dairy cows owned has a large and statistically significant impact on household cash income; each cow owned increased income by at least 53% of the mean total income of households without dairy cows**. Dairy cow ownership also increases consumption of dairy products by 1.0 litre per week, even though most of the increase in milk production is sold. The number of dairy cows has no significant effect on total labour for cattle-related tasks. However, in contrast to previous studies, labour allocation to cattle by household members decreases and labour requirements

ANNEX 2: SUMMARIES OF STUDIES USED FOR QUANTITATIVE ASSESSMENTS

for dairy cows are met primarily by an increase in hired labour. Dairy cow ownership results in relatively modest increases in payments to hired labourers and the number of hired labourers employed. The large positive impacts on income and the substitution of hired for household labour in cattle care suggest that intensification of smallholder dairying can be beneficial as a development strategy in the region if disease and feed constraints are addressed.

Rao et al. 2016 | East Africa

In this study we have analysed the effects of household linkages to milk market via dairy hubs currently implemented under the East African Dairy Development project. Our analyses show that participation in dairy hubs increases dairy revenues by USD 1,022 on average. **Impacts are higher for households participating in hubs supplying exclusively to processors (USD 1,673) relative to ones supplying hubs that pursue mixed-linkage approach. Moreover, participation in dairy hubs also yields significant effect on household income**. Appropriate measures should be undertaken to widen the reach of such processor linkages while also safeguarding existing gains, more so as the processing sector becomes more concentrated.

Rawlins et al. 2013 | Rwanda

International animal donation programs have become an increasingly popular way for people living in developed countries to transfer resources to families living in developing countries. We evaluate the impact of Heifer International's dairy cow and meat goat donation programs in Rwanda. We find that the program substantially increases dairy and meat consumption among Rwandan households who were given a dairy cow or a meat goat, respectively. We also find marginally statistically significant increases in weight-for-height z-scores and weight-for-age z-scores of about 0.4 standard deviations among children aged 0–5 years in households that were recipients of meat goats, and increases in height-for-age z-scores of about 0.5 standard deviations among children in households that received dairy cows. **Our results suggest that increasing livestock ownership in developing countries may significantly increase consumption of nutrient dense animal-source foods and improve nutrition outcomes**.

Squicciarini et al. 2016 | India

We started from a simple OLS analysis. Then, to deal with the concern that dairy producers are intrinsically different from non-dairy producers, we used propensity score matching, and to account for selection on unobservables, we relied on the Altonji et al. (2005) methodology. **In all cases, we find that dairy farming is positively associated with a higher income per capita. Using different estimation methods, we documented that dairy production is strongly and positively associated with improvement in rural livelihoods, in terms of income per capita**. Most importantly, we also found that the positive relation between income and dairy production holds for larger – more

commercial – dairy farms. It is not simply the fact of being a milk producer, but the switch from a herd size of 1-2 DA to a larger farm that is positively related with higher incomes. To fully promote development through dairy production amongst poor rural households, it's not enough to subsidize small dairy farmers, but to create the conditions to let them grow and engage in more a commercial dairy activity.

Tefurukwa 2011 | Tanzania

This study was conducted in Kasulu district (Tanzania) with the aim of assessing the impact of a dairy cattle project on the households' livelihoods. Muzye and Mnanila wards were surveyed. Purposive, stratified and simple random sampling techniques were employed to obtain the desired sample. Data were collected through a cross sectional survey from a sample of 120 respondents, 60 of whom had received dairy cattle and 60 without dairy cattle. A t-test showed a significant difference ($t=2.98$, $df=59$, $p<0.05$) between households' incomes before and after the project intervention. The mean annual incomes for dairy cattle owners increased from 471 267 to 1 012 400 TAS after the project intervention. In addition, farmers with dairy cattle had higher mean annual incomes (1 012 400 TAS) than those without dairy cattle animals (523 597 TAS). Integration of dairy and crop enterprises increased crop yields due to the application of cattle manure. Farmers with dairy cattle (93.3%) reduced application of industrial fertilizers after dairying compared to 51.7% of households without dairy animals. The observed overall mean cow performance in terms of daily milk yield, lactation length and dry period were 7.25 kg, 9.08 and 2.65 months, respectively. **It was concluded that small-scale dairy cattle enterprise had contributed significantly in improving households' livelihoods as regards to food security and increased purchasing power of goods and services. It is therefore recommended that guaranteed milk market, quality extension services and access to quality dairy animals will sustain the project. This calls for development partners to support farmers through small-scale dairy schemes**.

Employment generation in dairy value chains

Kumar et al. 2010 | Assam region in India

The employment generation in the informal milk markets has been found to be quite significant. For every 1 000 litres of milk marketed on a daily basis, 19.5 milk vendors (dudhias) get employment; these vendors on an average handle some 66 kg of milk per day. All these jobs are created in the form of self-employment. For milk processing and value-addition, employment for 57.8 man-days is created for 1 000 litres of milk in the traditional milk processing. The volume of milk marketed by the traditional sector in the state could translate into the estimated daily employment of 28 481 man-days, with raw milk traders accounting for 65 per cent and milk processors accounting for 35 per cent of

the total milk market employment. It does not include the persons employed in the formal milk processing sub-sector. **The employment created in the traditional milk marketing amounts to some 17 per cent of the estimated total direct employment of 0.17 million in the livestock sector in the state**.

Omore et al. 2004

Bangladesh | Unlike in Kenya, small dairy processors in Bangladesh seem to generate more jobs than the other agents. **Depending on the trade type, a wide range of level of job creation was observed for every 100 litres of milk sold; 0.02 to 5.6 direct jobs, and 0 to 4.4 indirect jobs**. The reason is likely to be the relatively more dominant processed milk market in Bangladesh that involves high value products, mainly sweets, in contrast to the predominant liquid milk market in Kenya. Most indirect jobs were in transport and porter services.

Ghana | **Ghana has a relatively high number of jobs created per 100 litres of traded milk compared with Bangladesh and Kenya. The direct jobs ranged from 1.7 to 10.0 per 100 litres of milk traded daily, with an additional 0 to 2.1 indirect jobs depending on the enterprise type**. Though the retailers do not report any indirect jobs, the total numbers of jobs they create at the retail level are more than double that of the other agents in small-scale dairy marketing and processing.

Kenya | **The overall number of both direct and indirect jobs created totalled from 0.3 to 2.0, depending on enterprise type, for every 100 litres traded**. Mobile milk trading created more employment (mostly self-employment) per 100 litres of traded milk compared with milk bars and small processors who nevertheless handled much more milk.

Economy-wide impacts of dairy industries

Jaques et al. 2011 | Canada

The dairy industry is one of the most important sectors of Canadian agriculture. The country's 12,965 dairy farms recorded milk sales of $5.4 billion and total farm revenue of $6 billion in 2009. These farm activities have direct, indirect and induced spin-offs involving over 125,000 Canadian jobs and $7.2 billion of GDP. The 452 dairy processing plants had sales of $13.7 billion. They generated over 85,000 jobs in Canada, and $7.9 billion of GDP. **Production and processing within the dairy industry thus account for over 215,000 direct, indirect and induced jobs and generate economic spin-offs totalling $15 billion in Canada. Dairy activity also generated $3 billion in tax revenue for municipal, provincial and federal government**.

Neibergs and Brady 2013 | Washington, USA

The economic multipliers of dairy farming, processing and cull cows in Washington state are about 1.85, 1.29 and 1.95 respectively. The estimated number of dairy farming direct jobs is 6,184 jobs, which is a full time equivalency job rate of 5,256 jobs. The total number of jobs due to dairy farming is 12,159 jobs. For dairy manufacturing the direct employment is 1,012 jobs and the total number of jobs due to dairy manufacturing is 4,497. **The total combined number of total jobs is 18,066**.

Rephann 2015 | Virginia, USA

In 2014, the Virginia dairy industry accounted for $2.298 billion in total output, 7,875 employees, $451 million in value-added, and $159 million in labor income. Dairy cattle and milk production is the largest component in terms of employment at 77 percent. **However, dairy product manufacturing accounts for over 60 percent of value-added. The purchases of the four value-added manufacturing industries play a key role in supporting Virginia dairy farm production. These state businesses account for the bulk (64.2 percent) of the dairy industry direct employment, output, value-added and labor income including 3,906 jobs, $307.8 million in output, $115.2 in value-added, and $16.1 million in labor income.** Other in-state purchasers (e.g., confectionary industries, other farm sectors) institutional purchasers (e.g., government), out-of-state purchasers and international exports account for the remainder of demand for the Virginia dairy farm industry.

Swanepoel 2014 | Colorado, USA

In the first chapter an Input-Output model was used to estimate the economic contribution of the combined dairy industry to the local Colorado economy. Due to the substantial increase in the dairy industry over the last decade, there was need to quantify the economic role of dairy industry, from dairy producers to dairy processers, and measure the linkages with allied industries in terms of output, value added, and employment contributions. **It was estimated that the total economic contribution of the dairy industry exceeded $3 billion in 2012, and accounted for roughly 4,333 jobs. In chapter two Class III milk futures contracts are examined for the presence of rational price formation due to increasing uncertainty surrounding revenue streams for dairy producers. Presence of rational price formation suggests an efficient market, allowing for increased confidence in the futures market. A system of 12 seemingly unrelated regressions is used to investigate rational price formation**. Futures contracts are found to be acting in an allocative capacity from 11 months to 3 months prior to expiration month. In the last 2 months, the forward pricing role is dominant taking into account the supply and demand dynamics in the market. It is found that Class III milk futures play both roles well, indicating that they are efficient in utilizing all information available through the last 12 months of trading.

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