



Impact of intensification of different types of livestock production in smallholder crop-livestock systems[☆]

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ABSTRACT

Intensification of livestock production is widely advocated to meet the increasing demands for livestock products and to contribute to improving the livelihoods of rural households. This paper discusses the impact of livestock intensification on smallholder farms using village poultry, integrated agriculture–aquaculture systems, small ruminants, and dairying case-studies. Driving forces for intensification in crop-livestock systems act at international, national, regional, and agro-eco system levels. Whether or not individual households respond to these drivers depends on the availability of household resources, the family situation, and livelihood alternatives. As livestock systems intensify, the relative importance of the various functions of livestock changes. The case-studies confirmed that, in terms of ‘returns’, there is a livestock ladder with the smallest benefits accruing from village poultry and the largest benefits provided by dairy cattle. Small animals are an appreciated secondary activity, or an essential source of security and small income for the very poor. The potential of intensification of small animal systems to substantially increase incomes of rural households appears to be low. Nevertheless, small animals are more suitable for micro-credit and livestock loans-in-kind programmes than large ruminants. Innovations in livestock production will only be adopted by smallholders if they fit farming household priorities and resources.

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1. Introduction

Worldwide, livestock production systems are rapidly changing. The increasing demand for meat, milk and eggs is a major driving force for these changes (Seré et al., 2008). Delgado et al. (2001) predicted that the demand for livestock products would double in the first two decennia of the 21st century, due to human population increases, urbanisation, economic progress and changing consumer preferences. The economic crisis of 2008 slowed down this trend, but it is expected that the growth in consumption of animal products in emerging and developing countries will remain strong. It is

often stated that the increase in demand for animal source food can help smallholder crop-livestock farmers to engage in market-oriented economic activities by intensifying their livestock production practises (Delgado et al., 2001; Devendra and Chantalakhana, 2002). However, in relative terms, increases in livestock production occur mainly outside the traditional rural sector (FAO, 2005a).

Intensification can be defined as the increased use of external inputs and services to increase the output quantity and/or value per unit input (Bebe et al., 2002). In practise, it is often understood as applying more ‘advanced’ management and thereby increasing production per animal and per labour unit. The type of livestock kept by household producers varies according to agro-ecological conditions and region of the world, and, within these determinants, is related to tradition, resources, family life cycle and wealth status (Bosma et al., 2006; Kristjanson et al., 2004). With respect to policy incentives, many countries promote the intensification of

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dairy production to reduce imports of dairy commodities. Also, within the ambit of the Millennium Development Goals (MDGs), most governments remain committed to poverty alleviation ([Lemke et al., 2008](#)) and intensification of small animal production systems is regarded as having the potential to contribute to improving the livelihoods of the very poor ([Devendra and Chantalakhana, 2002](#); [Dolberg, 2001](#); [Otte and Upton, 2005](#)). Thus, intensification of livestock production has become a major policy option, both to meet the increasing demand for livestock products and, at the same time, to contribute to improving the income of rural households. How does intensification of different types of livestock production live up to these expectations? This paper discusses the drivers and outcomes of intensification of livestock production in smallholder farms by drawing on the results of case-studies on village poultry, integrated agriculture–aquaculture systems, small ruminants and dairy cattle in Ethiopia (poultry), Vietnam (agri-aquaculture), Indonesia (small ruminants), India, Bhutan and Kenya (dairy cattle), respectively.

2. Methods

Mixed crop-livestock farms are complex systems and the assessment of impacts of changes on these systems cannot be covered by any single research approach. The case-studies drawn upon in this paper used diverse approaches, ranging from participatory appraisals, household surveys, monitoring of animal and farm level performances, to modelling the impact of innovation adoption.

In Tigray, Northern Ethiopia, [Akilu \(2007\)](#) explored the role of village poultry, their marketing and consumption, and possibilities for their improvement. He applied participatory assessment methods (individual and group discussions), surveys (involving 180 households and 1153 market actors) and longitudinal farm recording (131 households) from August 2003 to September 2004. Modelling of village poultry dynamics was used to foster joint learning between researchers and farmers about the potential impact of different innovations.

The Mekong River Delta in Vietnam is an example of a region where many farmers have diversified into Integrated Agriculture Aquaculture (IAA) systems. [Bosma \(2007\)](#) and [Phong \(2010\)](#) studied production performance and ecological sustainability of these integrated farms in the Mekong River Delta. The methodologies used included a baseline survey (90 farms) over the period 2002–2004, and daily monitoring of all inputs, outputs and on-farm product flows over these two years (11 farms). In addition, nutrient balances and Life Cycle Assessment (LCA) were used to quantify the environmental impact of farms and their components, in terms of land use, energy use, global warming potential, eutrophication potential and acidification potential per kg product, per kcal produced and per farm. Added to this, [Bosma \(2007\)](#) collected data on 144 farms to model decision making on diversification of farms in the Mekong River Delta.

[Budisatria \(2006\)](#) studied the dynamics of small ruminant production systems in Central Java, an area in Indonesia renowned for the quality of its small ruminants. He collected data through interviewing farmers (150 small ruminant farmers and 71 neighbouring households) and key informants ($n=30$), group meetings, field observations, and through

monitoring feeding practises, animal performances, air and water pollution, and marketing strategies.

Crossbreeding for dairying is a major tool in intensification of cattle production. The impact of crossbreeding local cattle with exotic dairy breeds goes much further than increasing milk yields. [Patil \(2006\)](#) and [Samdup \(1997\)](#) studied the impact of crossbreeding at farm level in mixed farming systems in Bhutan and Gujarat (India), respectively, by collecting data on household resources, inputs, outputs and internal resource flows of households with and without crossbred cattle. In Gujarat, data were collected from 311 mixed crop-livestock farms with Indian cattle breeds, or with Jersey or Friesian crossbreds ([Patil and Udo, 1997](#)). In Bhutan, data were collected from 73 mixed farms with local Siri or with Brown Swiss \times Siri crossbreds in a district with a temperate climate and a relatively well-developed infrastructure.

Kenya is prominent among developing countries for integrating dairy into smallholder farming systems, particularly in the highlands, where Kenyan farmers mainly use European dairy breeds: Friesians, Ayrshires, Jerseys, and Guernseys. A case-study on the consequences of intensification of smallholder dairying in the Kenya highlands involved a cross-sectional survey of 1755 households in 1996 and 1998, complemented with additional information from semi-structured, longitudinal interviews (repeated at monthly intervals over a period of one year) with 50 households ([Bebe, 2003](#)).

Estimates of contributions of livestock to livelihoods were based on estimates of value added (revenues minus variable costs) plus estimates of 'additional' benefits of livestock ([Bosman et al., 1997](#); [Moll, 2005](#); [Moll et al., 2007](#)). Revenues included the value of marketed products and the opportunity values of home consumption, manure, and use of cattle draught power. Home consumption could not be estimated in the integrated farms in the Mekong River Delta. Additional benefits represent the money saved by a household in a herd or a flock through the guarantee that future requirements can be met, equivalent to an insurance premium not required, and the expenses avoided by selling animals for urgent cash needs, i.e. saving of financing expenses incurred by engaging formal or informal agents. This is particularly relevant in areas lacking formal insurance and developed financial markets ([Bosman et al., 1997](#); [Moll, 2005](#); [Moll et al., 2007](#); [Udo and Cornelissen, 1998](#)).

3. Village poultry

3.1. General background and drivers of change

A large proportion of rural households keep poultry in their farmyard. Poultry provide food, a small cash income, and they play a symbolic role in hospitality, in exchange and in sacrifice ([Whyte, 2002](#)). Village poultry development projects are expected to increase self-reliance, in particular for women ([Mack et al., 2005](#)). In Tigray, the main benefits derived from village poultry was income from sale of eggs and sale of birds, followed by egg and meat consumption in the family, and strengthened social relationships. Female-headed households were more focussed on poultry than male-headed households. Female-headed households often only kept poultry, whereas male-headed households had a wider range of

opportunities for earning income. A local expression was that 'poultry is the first and last resource of the poor' (Aklilu et al., 2008). Financial resources of poor households were often so scarce that they had to use poultry-sharing arrangements to start poultry keeping. Sales and consumption of chickens and eggs overlapped with the major social and religious festivals. Sellers indicated a shift in demand from beef and small ruminants to poultry for consumption. A major advantage of poultry was that there is no need for storing meat, unlike for beef, and sheep and goat meat (Aklilu, 2007). Prices of birds and eggs had more than doubled over the last ten years due to the increase in number of consumers and the introduction of chicken on menus in local restaurants.

Village poultry innovations require additional cash inputs for their adoption. This means that farmers have to become more market-oriented. In Tigray, access to markets was strongly associated with distance to markets and marketing infrastructure, and the availability of household resources (Aklilu et al., 2007).

3.2. Outcomes

For Tigray in 2003–04, the benefits from sales and home consumption of poultry were estimated at around 70 US\$ y^{-1} per household. Modelling of the impact of innovations showed that New Castle Disease (NCD) vaccination could double these benefits (Aklilu, 2007). But, NCD vaccination is currently not carried out in Tigray. The modelling showed that housing, supplementary feeding, and control of broodiness each could have a positive effect on technical parameters. Housing, however, had a highly negative impact on economic benefits. Housing helps to protect poultry from predators, but it implies that the chickens have to be cared for, the farmer has to provide feed and water. Supplementary feeding also showed a negative response in benefits. The impact of crossbreeding was highly negative due to high mortality rates and loss of broodiness. Feedback workshops with farmers on modelled technical and financial outcomes, showed that the local context and individual poultry-keeping practises determined the likely options for innovations (Aklilu, 2007). There was no one village poultry development package that fitted all.

4. Integrated agriculture–aquaculture systems

4.1. General background and drivers of change

SE Asia has a long tradition of integrated farming with rice, fruits, vegetables, fish and livestock. In the Mekong River Delta, these farming systems have changed from self-sufficiency systems, producing mainly rice with some fish and pigs and poultry for home-consumption to market-oriented Integrated Agriculture Aquaculture (IAA) systems. The potential benefits of integrated systems are: risk spreading, a more even distribution over the year of cash-generating opportunities, and more efficient resource use (Prein, 2002). Manure from pigs and chickens and human wastes are used to fertilise the fish pond. The pond sediments can subsequently be used to fertilise the crops and fruit trees, of which the residues, in turn, can be used as feed for livestock. Economic liberalisation in 1986, the introduction of

modern rice varieties, big floods in 1997 and 1998, and increasing market demands were driving forces for agricultural diversification and intensification (Phong et al., 2007). The majority of the farms included in the baseline survey had four farm components. Whether or not an individual household practised a specific component and integrated different components depended on, in decreasing order, available family labour, wealth status, land area, family situation (life cycle, number of young children, attitude to risk-taking, and age of the household head) and market prices (Bosma, 2007).

Intensification of the different IAA components was based mainly on the use of external inputs. In particular, farmers with sufficient capital tended to intensify their farming practises. The use of inorganic fertilisers was the main intensification strategy for the crop components on IAA farms. The use of concentrates and hybrid pigs were major tools in intensification of pig production. The intensification level of the fish component differed between areas. The use of concentrates and monoculture of catfish were the intensification strategies for fish in areas with access to urban and international markets. In areas with less intensively managed fish ponds, fish were fed mainly with pig, poultry and human excreta, and crop residues. The fish production system on these farms was poly-culture for domestic markets and home consumption.

4.2. Outcomes

Value added estimates for the whole farm were on average, 900 and 1240 US\$ y^{-1} for 2002 and 2004, respectively. There were no significant differences in economic results between different IAA management systems. The share of farm income was highest for rice, followed by fruits, fish, pigs, cash crops and poultry (Phong et al., 2007). In 2004, the returns for poultry were negative, due to the Avian Influenza (AI) outbreaks in 2003 and 2004. AI caused a considerable decrease in demand and in the prices for poultry products, whereas the demand and prices for fish and pork increased. The farmers responded by intensifying the aquaculture component and pig production. Thus, the IAA farmers were able to respond very quickly to the AI outbreaks and changes in market demands, an example of the resilience of integrated smallholder farms (Holling, 1995). On the other hand the AI outbreaks severely affected farmers who had specialised in poultry production (Phong et al., 2007).

The substantial N surpluses on IAA farms suggested that intensification of rice, fruit trees and vegetables resulted in accumulation of nutrients in soil pools (Phong, 2010). The LCA indicated that the environmental impacts, greenhouse gas emissions, eutrophication and acidification, per kg fish were higher in the low input fish system than in the medium and high input fish systems, due to the small fish yields in the former. The differences in intensification level (use of concentrates and species kept) between the high and medium input fish systems did not result in differences in environmental impacts per kg of fish produced. The medium input fish ponds were better integrated with the other farm components than the intensively managed fish ponds. Overall, rice (on average, 0.8 ha paddy per farm) and pigs (on average, 11 pigs per farm) were the main contributors to

the environmental impact of food production in the Mekong River Delta. Excessive use of fertilisers and methane emission from the paddy fields contributed most to the environmental impact in rice. The off-farm impact of the production of concentrates contributed most to the environmental impact in pig production (Phong et al., 2011).

5. Small ruminants

5.1. General background and drivers of change

Many authors state that small ruminants can make a contribution to improving livelihoods of the rural poor (Devendra and Chantalakhana, 2002; Lebbie, 2004; Morand-Fehr and Boyazoglu, 1999; Peacock, 2005; Sinn et al., 1999). This is mainly based on the fact that sheep and goat keepers usually belong to the poorer groups (Kristjanson et al., 2004; Morand-Fehr and Boyazoglu, 1999).

In Indonesia, over about 80 years of small ruminant development, the motives for keeping small ruminants remained the same, although major changes have occurred in animal numbers, breeds, and husbandry. The case-study farmers referred to their small ruminants as a saving that provides security and helps to accumulate capital. Manure was the second reason stated for keeping small ruminants. Farmers use sheep and goat manure as fertiliser for their fruit trees and paddy fields. Drivers of change in small ruminant systems have acted at national, regional, agro-ecosystem and household levels (Budisatria et al., 2007b). Over this period of 80 years the population of small ruminants in Indonesia increased seven-fold (Barwegen, 2005). Farmers have replaced their Javanese thin-tailed sheep by fat-tailed sheep (originally imported by Arab traders from south-west Asia). The promotion of Etawah goats (originally Jamnapari goats imported from India in the colonial period) by governmental institutions resulted in the change from local Kacang goats to Etawah-grade goats. The intensification of land use resulted in declining grazing areas and less family members available for herding small ruminant flocks. The majority of small ruminants are now kept in confinement, or in a combination of grazing and confinement. Cropping patterns very much determined the type of animal kept. In the lowlands, many farmers processed cassava and used the peelings for feeding sheep (30% of the diet both in the dry and wet season). Farmers were afraid to feed cassava peelings to goats. In the lowlands, goat farmers fed maize straw instead (36% of the diet). Goats were mainly kept in upland areas with abundant availability of legume tree leaves. In the wet season, goats were fed with legume leaves (about 25% of the diet). Farmers perceive that goats need better quality feed than sheep. The main type of feed was grass collected from fields and road sides (about 60% of the fresh feeds fed). In the wet season, goat farmers also fed elephant grass. In the dry season, all sheep and goat farmers fed small amounts of rice bran. Sheep farmers had better access to rice bran, because sheep are more integrated with rice production than goats (Budisatria et al., 2010).

The local government launched many small ruminant development programmes, such as group housing, milking goats, animal sharing programmes, slatted floors and village breeding units. The last three programmes were adopted.

Programmes often failed because of lack of awareness of farmers' priorities and resources. The resources at household level, i.e. family labour, time and capital availability, also were the major factors determining whether farmers kept small ruminants or not (Budisatria et al., 2007b).

In Indonesia, small ruminants, in particular sheep, play a key role in religious festivities since the majority of people are Moslem. In the case-study areas, the demand, supply and prices of small ruminants increased 1.5–3 fold during the weeks before the Moslem feast of sacrifice (Budisatria et al., 2008). Farmers hardly profited from this increased demand. The small number of animals (4–6) they keep makes it too difficult to plan the sale of males with a minimum body weight of 25 kg during the period when the prices increase. Urgent cash needs, e.g. for school fees and preparation of rice fields, were the main reason for selling small ruminants. Farmers rarely sold their animals directly on the small ruminant market or to the consumers: more than 80% of the small ruminants were sold to village collectors. The farmers in this study also complained that there was no marketing information available to them except for the information they received via the village collectors (Budisatria et al., 2008).

5.2. Outcomes

The economic benefits for households from sheep and goats were small: 120–165 US\$y⁻¹. In the uplands, the benefits of goat flocks were 25% higher than those of sheep flocks. In other agro-ecological zones the differences in technical and economic performances between goat and sheep flocks were small. The returns per unit of family labour from sheep or goat keeping were well below the minimum labour wage. A main reason for this was the high labour demand for daily management (mainly feed collection and cleaning the sheds). For their 4–6 animals, households spend 3.5–4.2 h d⁻¹. Farmers with sufficient household labour, however, do not consider the use of family labour as a production cost, because alternative employment opportunities are limited, particularly in upland areas with poor infrastructure, or because household members are not competitive in the job market.

Small ruminants had little impact on air quality inside and around small ruminants' houses. An exception was methane emission in an area where manure was stored inside the pens for several days. The housing of small ruminants close to the family quarters resulted, however, in very high levels of faecal bacteria contamination of drinking water sources (Budisatria et al., 2007a).

Exploration of innovation scenarios indicated that if lowland farmers can specialise in sheep fattening on the basis of rice bran supplementation or in goat breeding the technical and economic performance can be improved 1.3–2.2 times relative to current production systems (Budisatria et al., 2008). However, the returns to labour remain below the minimum labour wage.

It is unlikely that small ruminants will become the main income earner in rural households in Java. However, if households have spare family labour to manage small ruminants, they are an appreciated secondary activity (Budisatria, 2006).

6. Dairy development

6.1. Crossbreeding for dairying in Gujarat (India) and Bhutan

6.1.1. General background and drivers of change

In many developing countries, farmers started dairying by crossbreeding local breeds with European dairy stock. In India, the central and state governments started dairy development through crossbreeding in the 1970's. In parallel, state governments motivated and supported other agencies, such as cooperatives and non-governmental organisations, to support dairy development to contribute to poverty alleviation in rural areas. These programmes often started with the introduction of Jersey and Friesian crossbreds through artificial insemination, as well as training in feeding and management. In Gujarat, crossbreeding for dairying was introduced by an NGO (non-governmental organisation), in 1985. In Bhutan, crossbreeding for dairying was stimulated by the 1985 breeding policy which promoted crossbreeding with Brown Swiss in the high altitude areas and with Jersey in areas with relatively good market access, and using local breeds in remote areas that have harsh environmental conditions. The government supplied Brown Swiss and Jersey semen to AI centres in different areas. Crossbreeding is expected to contribute to livelihoods and, at the same time, to reduce grazing in forests. Generally, crossbred cows are stall fed and are milked every day. So, crossbreds graze less in the forests than local cattle. In Bhutan, maintaining forests is a major policy objective.

6.1.2. Outcomes

In both Gujarat and Bhutan, households with crossbred cattle did not differ from households without crossbreds in terms of farm resources. The introduction of crossbred animals resulted in an increase in the density of agricultural throughputs: farms with crossbred cows used more external inputs for cattle and had higher outputs than farms without crossbred cows (Patil and Udo, 1997; Samdup, 1997). Consequently, in Gujarat estimates of value added by cattle were 64% higher in households with crossbreds compared to households with local cattle (400 vs 243 US\$y⁻¹). In Bhutan crossbreeding had an even bigger influence on milk production and estimates of value added by cattle were 10 times higher in farms with crossbreds compared to farms with local cattle (1030 vs 107 US\$y⁻¹). The data from the Bhutan case-study refer to a survey done in 1996 (Samdup, 1997). Information from 2004 indicated that most households in the case-study district had changed over to crossbred cattle. Local cattle are still dominant in remote areas with seasonal forest grazing systems and poor market access. Milk from these animals is processed by households themselves into cheese and butter, whereas milk from crossbreds is usually brought to milk collection centres.

The use of crossbred cattle is queried because of doubts whether crossbreds fit into existing mixed farming systems. In Gujarat, there were no differences in work load for livestock activities between households with and without crossbreds. There was also no difference in bullock use between the two types of households, although farmers with crossbred bullocks had to shift the working hours to the cooler parts of the day (Patil and Udo, 1997). Crossbred cows were fed better than local cows: they received 1.4 times more

concentrates, and about 1.2 times more green (weeds, forest grass, leaves, and cultivated forages) and dry (straws and dried grass) feeds. The green and dry feeds came both from off-farm and on-farm sources. The major limiting factor was the quality of the roughages available. Average milk offtake levels for crossbred Jersey and Friesian cows were around 5–6 kg per lactation day (Patil and Udo, 1997). Milk offtake of the Brown Swiss crossbred cows in Bhutan was about 5 kg per lactation day. In Bhutan, reproductive rates were low and calf mortality was high in 75% Brown Swiss crossbreds. In smallholder dairying, replacement stock (purebred or crossbred) is generally in short supply, because of low calving rates and high calf mortalities (de Jong, 1996).

6.2. Dairying in Kenya highlands

6.2.1. General background and drivers of change

In the Kenya highlands about 60% of the rural households have integrated dairy in their mixed farming systems. Major determinants of this are colonial history, favourable agro-ecology, supportive agricultural policies and the traditional value of milk in people's diet (Bebe et al., 2002). Kenyan crop-dairy farmers intensify their farming practises by shifting from free-grazing to semi-zero- or zero-grazing (stall feeding). The semi-zero- and zero-grazing farms already comprise over three-quarters of all smallholder dairy farms.

Households with dairy cattle had about twice as much land as households without dairy cattle. Some of the households without cattle produce forages for dairy farmers. Overall, the size of farms in the highlands has decreased by more than half over the past two decades, mainly because of subdivision through family inheritance. This shrinking of land holdings is a major concern with regard to the sustainability of current farming practises. The free-grazing farms produced replacement stock needed for the other farms, as semi-zero- and zero-grazing farms were unable to produce sufficient heifers for replacement. Intensification of dairy production can only continue when there is a minimum proportion of free-grazing farms to produce the replacement animals for the semi-zero- and zero-grazing farms (Bebe, 2003). However, with human population densities continuing to rise and landholding shrinking, it is inevitable that the number of free-grazing farms will continue to decrease.

6.2.2. Outcomes

Bebe et al. (2002) estimated that the total benefits of dairying were, on average, 1073 US\$y⁻¹ per farm, of which 56% was from non-market (home consumption, manure, and insurance and financing) benefits. The labour productivity of dairying was higher than for crops or wage labour (Moll et al., 2007). The zero-grazing farms produced more marketable milk per unit of land than the free-grazing and semi-zero-grazing farms. The zero-grazing farms, however, showed lower economic benefits for the households than the free-grazing and semi-zero-grazing farms.

When asked about constraints, farmers ranked scarcity of good quality feeds as the most important followed by lack of labour, poor animal performance and lack of cash to purchase inputs. The feeds fed were mainly low quality bulk feeds: crop residues, Napier grass, weeds, and roadside grasses. The use of concentrates was limited to, on average, 1 kg d⁻¹. The

dairy breeds used, Friesian, Ayrshire, Jersey, and Guernsey, did not differ in milk production: 5 kg per lactation day. Milk production levels did not differ among free-grazing, semi-zero-grazing and zero-grazing farms. Researchers and development practitioners recommend the use of the smaller dairy breeds (Jersey and Guernsey), because of the shortages of good quality feeds. Farmers, however, prefer Friesians because of their larger body size and higher market values, and the perception that Friesians can produce more milk, provided that adequate feeding is available (Bebe, 2003).

7. Discussion

The main objective of the intensification of livestock production is to increase farm household incomes. The case-studies are not directly comparable with regard to the economic benefits of different livestock types, but they confirmed that in terms of returns there is a livestock ladder with the smallest economic benefits from village poultry, followed by small ruminants, pigs, fish, local cattle, and the largest benefits from dairy cattle. In Kenya, the success of smallholder dairying is shown by the fact that dairy production has become the main farm income source for over 600,000 households with mixed crop-livestock farming systems. In the Kenya highlands about 60% of the rural households are involved in dairying. Households with dairy cattle had more resources than households without cattle (Bebe, 2003). The results from Gujarat and Bhutan confirm that crossbreeding for dairying has brought major economic gains for the households involved. Smallholder dairying is often competitive with large-scale dairy farms, as it uses family labour and has no high requirements for investments (de Jong, 1996). Staal et al. (2005) concluded that it has been most successful in countries with a strong dairy tradition. The case-studies showed that small animals are an appreciated secondary activity or an essential resource for the very poor. Some innovations in small animals showed potential to increase economic benefits, but small animals will rarely become main income earners and intensification of small animal management will not contribute much to the possibilities of households to take the next step up the livestock ladder. This will depend mainly on the availability of household resources (family labour, cash, land, and feeds) and the family situation.

Intensification involves a whole package of innovations based on external inputs, which implies that farmers have to produce more for the market and must depend less on the other functions of livestock for the livelihoods of their households. Thus, there is often a trade-off between increasing the benefits from marketed production and the additional benefits from livestock's non-cash functions (Moll et al., 2007). A result of intensification may therefore be a reduction of the resilience of smallholder systems.

Micro-credit and livestock loans-in-kind are popular ways in which poor households are provided access to livestock and intensification technologies. Farmers normally repay livestock loans-in-kind with female offspring. Aklilu (2007) and Bosma et al. (2005) concluded that development programmes stimulating livestock by credit, sharing or passing-on-the gift for poverty alleviation will be more effective if poultry, goats or pigs are distributed instead of cattle. Dolberg (2001) contended that livestock programmes for development of the

poor should start with poultry. The success of the Bangladesh poultry development model is based on access to credit with small and frequent repayments (Dolberg, 2001). Experiences in Vietnam showed that cattle passing-on-the gift proved to be a losing proposition for the poorest, their financial circumstances usually forced the sale of the cow before it gave a calf (Bosma et al., 2005). Houterman et al. (1993) explored the performance of a heifer-in-trust scheme in Tanzania. Their results indicated that only about 60% of the initial number of distributed heifers could be repaid. Main reasons for death of heifers were economising on use of acaricides, improper use of acaricides and jealousy (poisoning). Some animals were slaughtered or sold illegally. Also in Tanzania, Afifi-Affat (1998) found that only 20% of the households that had received a heifer had repaid the animal with a heifer after seven years. Todd (1998) concluded that larger animals can make the poor poorer because it takes time to pay back the loan.

In poultry, the choice is to promote innovations in village poultry or to apply industrial poultry keeping methods. Innovations in village poultry have to fit the limited physical and economic resources of the farming households (Aklilu, 2007; Udo, 1997). Industrial poultry production methods are relatively easy to copy. In almost every country there are small-scale poultry units involving commercial hybrids, compound feeds and industrial poultry housing methods. Industrial poultry keeping is very vulnerable to macro-economic disturbances. In SE Asia, industrial poultry units suffered most from the Asian economic crisis in the late 1990's because of their reliance on imported feeds and the decrease in buying power of the consumers (Ørskov, 1999). The same situation occurred after the economic crisis of 2008. Globalisation and the expected liberalisation of trade also imply that local producers have to compete with imported products. In West Africa, the increasing demand for poultry products has a negative effect on local industrial poultry production, as the poultry meat demands are increasingly met by imports of whole chickens or inferior cuts (Dieye et al., 2007). Local poultry meat from small- or large-scale industrial units costs more than imported chicken products as a consequence of the higher production costs of feed and chicks.

A second objective of intensification of livestock production is to increase local production of livestock products. In Kenya, exports of milk and milk products are increasing and imports are decreasing (Noah and Waithaka, 2005). Smallholder dairy farmers produce about 80% of the total milk production. In Bhutan, however, the implementation of crossbreeding policies with smallholder farmers has not been able to reduce the gap between supply and demand for dairy products; imports of milk and milk products are increasing. These imports come from India, the country with 70 million smallholder dairy producers. In India, as in many other developing countries, the informal milk market has about 80% of the market share (Patil, 2006). This is the most economical way of milk marketing, but it might be a risk in milk safety (Staal et al., 2005).

Another objective of intensification could be to reduce the environmental burden of livestock production. Worldwide, the increase of livestock production is causing pollution of water, air and soil and contributes much more to greenhouse gas emissions than was appreciated earlier (Steinfeld et al.,

2006). Steinfeld et al. (2006) suggested that intensification of the livestock sector will help to mitigate greenhouse gas emissions, as less greenhouse gas is produced per kg of intensively-produced animal product than per kg of product from an extensive production system. The LCA results for the IAA farms indicated that reality might not be that straightforward. In the Mekong River Delta, the major tools for intensification are the use of fertilisers and concentrates. Their use contributed to a large extent to the environmental impact of food production through on-farm and off-farm processes. The environmental impact per kg of fish produced in intensively managed ponds was the same as in medium intensively managed ponds. The medium intensity fish ponds used more nutrients from waste products from other components on IAA farms. The water exchange rate was higher in the intensively managed fish ponds than in the medium intensity fish ponds, as farmers had to remove the excess of nutrients from the feeding of concentrates to their fish (Phong, 2010). Intensification might reduce environmental pollution per unit product but may increase environmental pollution per unit area. In Central Java, the housing of small ruminants close to the family quarters resulted in very high levels of drinking-water contamination with faecal bacteria. Reduction of biodiversity and domestic animal diversity are also components of environmental impact of livestock production. In most developing countries, cross-breeding has become a standard approach to intensification of livestock production. Hence, the local animal genetic resources are one of the big losers of this means of livestock intensification (Thomas et al., 2002). In Bhutan, one of the policy objectives of promoting the keeping of fewer but more productive crossbred cattle was to reduce grazing in forest areas. This has been successful to some extent.

Pica-Ciamarra (2007) concluded that, in general, the livestock revolution has not sufficiently translated into incentives for smallholders. FAO has estimated that large-scale commercial livestock operations are growing twice as fast as traditional mixed farming systems (FAO, 2005a). In Asia, where the growth of livestock production has been most substantial, large-scale industrial production accounts for roughly 80% of the total increases in livestock products since 1990 (FAO, 2005b). Although large-scale industrial livestock production is more responsive, the increasing demands for animal source food are influencing smallholder livestock production too. The market for milk is the major pull factor for smallholder dairy development. Increasing demands resulted in increasing prices for village poultry products in Ethiopia. In Indonesia, the demands for sheep during the feast of sacrifice are increasing too. Each Moslem family with a higher living standard would like to slaughter a sheep for the feast of sacrifice, and the number of people with a higher living standard has considerably increased over the past two decades (Budisatria et al., 2008). Smallholders, however, can often not respond to the growing markets due to inherent characteristics of their farming systems. Population increases are causing intensification of land use, disappearing grazing areas and shrinking farm sizes, as a result ruminants have to rely more on crop residues and forage from road sides or other marginal lands (rather than grassland). In Bhutan, India and Kenya, milk production levels were around 5–6 kg per lactation day. It seems that the feed resources available on

smallholder mixed farms (some grazing in communal areas, crop residues from the farm and small amounts of local concentrates) can only support such production levels. In Gujarat, modelling studies and field trials indicated that feeding more locally available supplements could increase milk yields at the most by 1 kg per lactation day (Patil, 2006). Another example is that Indonesian small ruminant farmers do not strategically make use of the increasing demands during the feast of sacrifice as they keep too few animals to be able to plan the sale of animals in the period when the prices increase. In general, animals are sold when the owners have urgent cash needs.

The integration of smallholders into a market framework could lead to increased competition with other smallholders and with large-scale operators. This competition takes place in markets that are becoming more demanding in terms of product quality and food safety. The policy and institutional framework has to be conducive to the needs of the resource-poor farmers, otherwise the rapidly increasing demands for livestock products will almost completely be satisfied by industrialised production systems.

8. Conclusions

Smallholder dairying, based on European dairy breeds or crossbreds, proved to be a good means to increase household incomes. A paradox is that poultry, pigs or small ruminants better fit the farming conditions of the very poor, but their contribution to household incomes is small. Livestock intensification policies focus on marketed production and tend to neglect the additional benefits gained from non-marketed products and from intangible insurance and financing benefits. Given the market “pull” factors, it is expected that livestock production will intensify further. In all the case-studies it was reported that intensification necessitates increased use of purchased inputs and services, such as feeds, replacement stock, breeding and health services and with these, a need for credit, producer organisations and market access for both inputs and outputs, and an increase in knowledge. However, the major determinants for farming households to change their livestock systems are availability of household resources and the family situation.

A major trade-off of livestock intensification is that only a part of the smallholder mixed farmers, in particular the better-off farmers, is able to take advantage of the increased demands for livestock products. It remains questionable whether the poorer households will, and can, be interested in investing their scarce resources and efforts in more intensive livestock systems. The social, cultural and capital asset functions of livestock will remain important for these households. Without development policies that deliberately consider the opportunities and threats faced by mixed crop-livestock farming households, many of these households are likely to be excluded from the increased market opportunities.

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