

Full Length Research paper

Livestock and livelihoods: Development goals and indicators applied to Senegal

D. Roland-Holst¹ and J. Otte²

¹Department of Agricultural and Resource Economics, University of California, Berkeley.

²Director of the Pro-Poor Livestock Policy Initiative (PPLPI).

Accepted 30 May, 2007

In this report, we present a series of empirical techniques to examine linkage between livestock and livelihood, using data from Senegal, a West African economy with high levels of smallholder poverty and livestock dependence. Our results for this country show that livestock dependent populations are more likely to be poor and the severity of their poverty is greater, yet the same reliance on livestock also offers a way to mitigate their adversity. By analyzing market linkages and supply chains in the livestock sector, we find that rural household producers capture only a small fraction of the ultimate value of their products. Moreover, we find that generalist agricultural promotion policies may be of limited value to them because most of the value created by these policies can be captured by downstream market participants. Our primary conclusion is that livestock holds substantial potential for poverty alleviation, but that carefully targeted policies are required to realize this potential.

Key words: Livestock, Poverty, Senegal, MDGs.

INTRODUCTION

Livestock's potential to improve livelihoods of the rural poor depends on complex economic linkages and behavior. In recognition of this, a special research component of PPLPI is dedicated to elucidating the economic fundamentals of smallholder livestock production. Called Integrated Poverty Assessment for Livestock Policy (IPALP) this approach seeks to elucidate the role of markets, prices, and private incentives in determining rural household investments, production patterns, and livelihood outcomes. The goal of this work is to support more effective pro-poor policies at all levels, but to focus on implementation and incidence at the rural smallholder level. With the benefit of improved sector data and detailed micro-economic surveys, we see again and again the importance of livestock to smallholder livelihoods. The challenge before us is to translate livestock dependence into a sustained source of income growth. In most of the cases examined so far, improving the terms for smallholder participation in food markets offers the best means of doing this.

The importance of livestock to smallholder livelihoods around the world is well understood. Animals are an essential asset to the rural poor, both those directly engaged in agricultural production and poor non-farm rural households who rely on local production for affordable nutrition. In the West African context, livestock dependence is remarkably high. Large arid expanses in this region are best suited to livestock-oriented agricultural production, where extensive land use is required to sustain populations and mobility has historically been important for coping with climatic variability. Figure 1 reveals West African livestock dependence from a macroeconomic perspective, and these results are remarkable by international standards. The average contribution of livestock to agricultural GDP for the region (intersection of the two axes) exceeds 25 percent, and has been remarkably stable for most countries over a decade. This contrasts sharply with OECD economies, where the same ratio is less than 2 percent.

In this study we aim to examine linkages between livestock and livelihoods by applying a suite of empirical techniques combined in IPALP to data from Senegal, a West African economy with high levels of smallholder poverty and livestock dependence. We also use this case

*Corresponding author. E-mail: wrh00@gmail.com

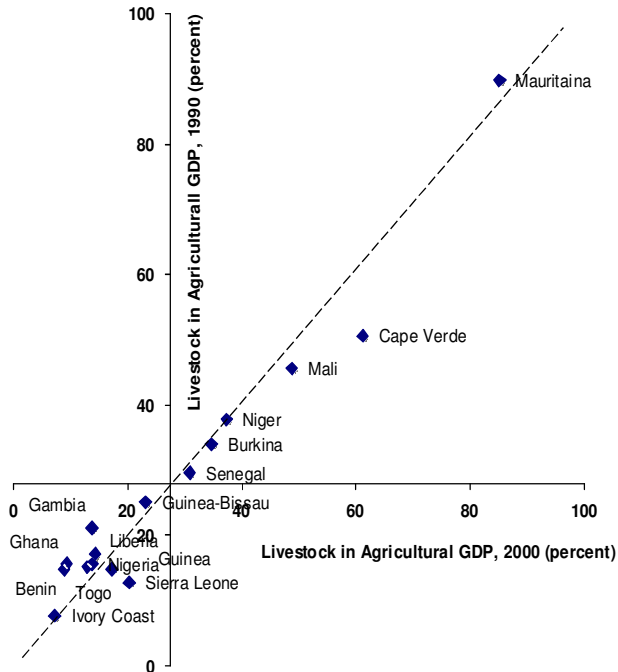


Figure 1. West Africa: National livestock dependence.

to test a set of indicators of pro-poor livestock sector development for their utility in providing guidance for and measuring the impact of livestock sector related policy interventions.

Goals and indicators for livestock development

As part of its commitments to advancing livestock's contribution to poverty alleviation, the FAO's Pro-Poor Livestock Policy Initiative (PPLPI) has formulated a set of overall development objectives and is developing metrics to assess progress toward them (see Roland-Holst and Otte:2006). These objectives have been named the Livestock Development Goals (LDGs) to evoke their close relationship with the more general Millennium Development Goals (MDGs) promulgated by UN institutions to assess progress in global living standards. While the livestock development goals and indicators are of independent relevance and interest to PPLPI and livestock policy makers, their conformity with the MDGs recognizes the usefulness of the latter in the international development dialogue and is also intended to emphasize the integral contribution of livestock to improving the livelihoods of the majority of the world's poor who live in rural areas.

Livestock development goals

Goal 1: Eradicate extreme poverty: Halve between 1990 and 2015 the proportion of livestock dependent people whose income is less than 1\$/day.

Goal 2: Increase smallholder food security and protein sufficiency: Promote gender-balanced policies to enhance the role livestock as a source of income and protein. Reduce by 2/3 malnutrition among smallholders by 2015.

Goal 3: Increase smallholder value-added: Double budgets for public investment enhancing smallholder access to extension services and markets by 2015, with emphasis on public actions that raise productivity and reduce livestock market distortions.

Goal 4: Improve animal health and welfare: Promote higher standards for animal health, husbandry, including hygienic and humane production and processing practices.

Goal 5: Combat epidemic and zoonotic diseases: Avert major epidemics and reduce the incidence of trans-boundary animal diseases and zoonoses by 1/2 by 2015.

Goal 6: Ensure sustainability of livestock keeping: Integrate the principles of sustainable development into livestock policies and programs. Avoid overstocking and promote sustainable patterns of land and water use, agrochemical and pharmaceutical application.

Goal 7: Conserve indigenous livestock varieties: Maintain a complete inventory of domestic livestock varieties, including detailed scientific and economic descriptions, and promote conservation of legacy genetic material.

Goal 8: Develop a global partnership for pro-poor livestock policy development, market standards and technology sharing: Establish a clearing house for dissemination and sharing of intellectual property, genetic material, and technologies related to livestock production, processing and marketing.

To give empirical substance to these goals, we have proposed a series of quantitative progress indicators. In this report, we focus of the first goal, and apply four Livestock Development Indicators (LDIs) to the Senegalese context to gain deeper insights about links in this country between livestock and the livelihoods of the poor. To begin, we define the Livestock Dependent (LD) population as the population headcount, weighted individually by livestock income as a share of total income.

Livestock Development Indicators for Goal 1: Eradicate extreme poverty

- Livestock Dependent (LD) population living below \$1 (PPP) a day.
- Poverty headcount ratio (percent of LD population below national poverty line)
- Proportion of LD population living below national poverty line?
- Poverty gap ratio (incidence x depth of poverty).
- Share of poorest quintile in national consumption.

Proportion of livestock dependent population below \$1 (PPP)/day

Definition¹

Proportion of LD population below \$1 per day (extremely poor) is the percentage of the population living on less than \$1.08 a day at 1993 international prices, with each income unit of the population weighted by the share of livestock income in total income.² The \$1 a day poverty line can be based on expenditure or income per person and includes consumption from own production and income in kind. Because this poverty line has fixed purchasing power across countries or areas, the \$1 a day poverty line is often called an absolute poverty line. The indicator allows for comparing and aggregating progress across countries in reducing the number of people living under extreme poverty and for monitoring trends at the global level.

METHOD OF COMPUTATION

The basic formula for this indicator is a headcount poverty measure, defined with respect to an exogenously specified poverty line and formally expressed as follows:

$$LDI1.1 = \frac{q_{LD}}{n_{LD}}$$

Where

$q_{LD} = \sum_{i=1}^q \lambda_i$ = cumulative livestock dependence among the poor

$n_{LD} = \sum_{i=1}^n \lambda_i$ = cumulative livestock dependence in the population

λ_i = share of livestock income in total income of household i

International poverty is regularly based on a \$1 a day poverty line. Estimates are based on income or consumption levels derived from household surveys. Whenever possible, consumption is preferred to income for measuring poverty. When consumption data are not available, income is used.

Consumption, which includes consumption of own production, or income per person, and its distribution are estimated from household surveys. Household consumption or income is divided by the number of people in the household to establish the income per person.

The distribution of consumption or income is estimated using empirical Lorenz (distribution) curves weighted by household size. In all cases measures of poverty to obtain Lorenz curves are calculated from primary data resources rather than existing estimates.

Prevalence of extreme poverty in a country is estimated by converting the \$1 a day poverty line to local currency using the latest purchasing power parity (PPP) exchange rates for consumption taken from World Bank estimates. Local consumer price indices are

then used to adjust the international poverty line in local currency to prices prevailing around the time of the surveys. This international poverty line is used to identify how many people are below the \$1 day thresholds.

The PPP-based international poverty line is required only to allow comparisons across countries and to produce estimates of poverty at the aggregate level. Most countries also set their own poverty lines (see indicator 1.2).

Poverty headcount ratio (% of population below the national poverty line)

Definition

The poverty headcount ratio is the proportion of the national population whose incomes are below the official threshold (or thresholds) set by the national government. National poverty lines are usually set for households of various compositions to allow for different family sizes. Where there are no official poverty lines, they may be defined as the level of income required to have only sufficient food or food plus other necessities for survival. This indicator allows for monitoring the proportion of the national population that is considered poor by a national standard. Most poverty analysis work for countries is based on national poverty lines. National poverty lines tend to increase in purchasing power with the average level of income of a country.

Method of computation

Household income (or consumption) and its distribution are estimated from household surveys (see indicator 1.3). The incomes of various household types, by composition, may then be compared with the poverty lines for those types of household. If the poverty lines are expressed in terms of income per adult equivalent or some similar measure, the incomes of the households must be measured on a similar basis. Household income may be converted to income per adult equivalent by using the modified equivalence scale of the Organization for Economic Co-operation and Development (OECD) — in which the first household member over 16 equals 1, all others over 16 equal 0.5, all under 16 equal 0.3—or some other equivalence scale. Household incomes are then divided by the 'equivalized' number of people in the household (two adults would equal 1.5 according to the OECD scale) to establish income per person.

Once the number of households that are below the poverty line has been estimated, the number of people in those households is aggregated with livestock dependency weights to estimate the percentage of the LD population below the line.

Poverty gap ratio (incidence x depth of poverty)

Definition

Poverty gap ratio is the mean distance separating the population from the poverty line (with the non-poor being given a distance of zero), expressed as a percentage of the poverty line. This indicator measures the 'poverty deficit' of the entire population, where the poverty deficit is the per capita amount of resources that would be needed to bring all poor people above the poverty line through perfectly targeted cash transfers.

Method of computation

The poverty gap ratio is the sum of the income gap ratios for the population below the poverty line, divided by the total population, which can be expressed as follows:

$$LDI1.3 = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)$$

¹ The specification of several LDGs draws heavily upon the precedence of MDG work by other UN/CGIAR institutions and the World Bank in particular.

² Livestock income includes sales of animals, animal products, and animal services.

Where z is the poverty line, y_i is the income of individual i , q is the number of poor people and n is the size of the population. The poverty gap can also be expressed (and thus calculated) as the product of the average income gap ratio of poor people and the headcount ratio, LDI 1.1 or LDI 1.2 above. Note that

$$\sum_1^q (z - y_i) = \text{total income deficit of the poor} = \text{minimum cost to}$$

eliminate poverty with perfect targeting, and

$$LDI1.3 = \frac{\sum_1^q (z - y_i)}{nz} = \frac{\text{Targeted welfare budget}}{\text{Untargeted welfare budget}}$$

1- LDI1.3 = Gain from targeting = % of untargeted budget saved.

All these formulas are calculated using data on individuals (y_i as individual income or consumption). If household-level data are used, the formulas have to be adjusted by the weight w_i , which is the household size times the share of livestock income in total income and a sampling expansion factor for every household i .

Share of poorest LD quintile in national consumption

Definition

The share of the poorest LD quintile in national consumption is based on share of total expenditure represented by the poorest fifth of the population. This indicator provides information about the distribution of consumption or income of the poorest fifth of the population. Because the consumption of the poorest fifth is expressed as a percentage of total household consumption (or income), this indicator is a 'relative inequality' measure. Therefore, while the absolute consumption of the poorest fifth may increase, its share of total consumption may remain the same (if the total goes up by the same proportion), decline (if the total goes up by a larger proportion) or increase (if the total goes up by a smaller proportion).

Method of computation

Detailed patterns of household income and consumption are estimated from household surveys. Household income is adjusted for household size to provide a more consistent measure of per capita income for consumption. Household income is divided by the number of people in the household to establish income per person. The population is then ranked by income. The income of the bottom fifth is expressed as a percentage of aggregate household income. The calculations are made in local currency, without adjustment for price changes or exchange rates or for spatial differences in cost of living within countries, because the data needed for such calculations are generally unavailable.

Patterns of poverty and livestock dependence in Senegal

In this section, we examine the relationship between livelihood and livestock in greater detail, using the case of Senegal as an example. Senegal represents the West African experience relatively broadly, with high population shares in arid areas engaged in subsistence agriculture with significant levels of economic dependence on livestock. By extension, the findings for Senegal have implications for poor rural populations in subsistence rangeland and livestock-reliant agriculture in other countries in Africa and around the world.

Regional income characteristics of Senegal are summarized in Figure 2, which presents traditional poverty headcount ratios by province, using both global (\$1/day) and national standard poverty lines. In the latter case, poverty lines are adjusted for local purcha-

sing power. Thus in Dakar, globally calibrated poverty is relatively low (under 10 percent). This situation merely reflects higher nominal urban wages, however, and after taking account of much higher urban living costs, Dakar's poor population swells to over 60 percent. Indeed, PPP adjustments lead to higher poverty rates in all regions of the country, but the disparity is highest in the capital. A similar but less dramatic cost of living effect can be seen in Saint Louis, home of Senegal's second largest urban area. Conversely, provinces with high proportions of subsistence rural population, such as Kolda and Fatick, are less vulnerable to formal sector prices than low income groups in the capital. Indeed, this price dualism is an important positive dimension of livestock dependence. It implies income prices have upside potential, while consumption price vulnerability is buffered by food self-sufficiency.

Deeper insight into the role of livestock in this dualism can be obtained by examining LDI1.1, the corresponding poverty headcount for LD populations. Figure 4 compares the overall, globally calibrated poverty headcount (denoted MDI1.1) with its counterpart (LDI1.1) adjusted for livestock dependence of the population. Here we see that, among the livestock dependent, extreme poverty rates average nearly 20 percent higher. Moreover, the disparity is highest in areas where rural subsistence populations predominate, such as Kaolack and Kolda. This fact, higher representation among the poor by livestock dependent people, reinforces the importance of livestock as a target for poverty alleviation.

Figure 5 compares LD poverty prevalence across provinces and the provincial contribution to national LD poverty. For each province, the yellow column shows the LD percentage poverty headcount (LDI1.2). Note here that we use the national poverty lines for each province (as in Figure 3). The headcount can be thought to measure the prevalence of poverty within a province. By contrast, the red line values (measured on the right vertical axis), indicate each province's contribution to national LD poverty, in other words the 'density' of national poverty among provinces. As a practical matter, this difference means, for example, that Dakar, Kaolack, and Thies are leading demographic centers of Senegal's LD? poor, and should be primary targets for national poverty alleviation strategies. Poverty is very common in Kolda and Fatick, exceeding 85% in headcount terms, yet none of these provinces represents more than 10 percent to the nation's poor. Louga is distinguished by relatively low rates of both local and national poverty representation.

As explained in the previous section, the poverty gap measure LDI1.3 indicates the per capita national cost of targeted transfers that would bring the poor up to the poverty line, expressed as a percentage of the value of poverty-line income for the population as a whole. In Figure 6, this indicator for Senegal as a whole is compared to the corresponding provincial measures and indicators of each province's contribution to the national gap are provided (in red). The national poverty gap (first green column) shows the typical fiscal challenge developing countries face when contemplating poverty alleviation with transfer schemes. With a gap equal to about 35 percent of all potential poor income (that is, for every \$ the poor earn they would need another 0.35\$ transfer to reach the poverty line?), Senegal is unlikely to find a publically financed transfer scheme that can significantly alleviate the nation's poverty.

This challenge is particularly acute in Dakar, where over 25 percent of the burden of Senegal's poverty gap (red line, right axis) is concentrated. Rural provinces like Kaolack and Thies also have large gaps and contribute significantly to the national gap, yet here livestock policy can facilitate self-directed poverty alleviation through greater food market participation. In the predominantly rural provinces, food market policies can also improve the agricultural terms of trade, reducing the pressure to migrate and thereby increase the fiscal burden of urban poverty alleviation. Comparisons like this indicate that one size will not fit all areas where anti-poverty strategy is concerned, and that governments should decompose regional poverty indicators in this functional way to target more appropriately.

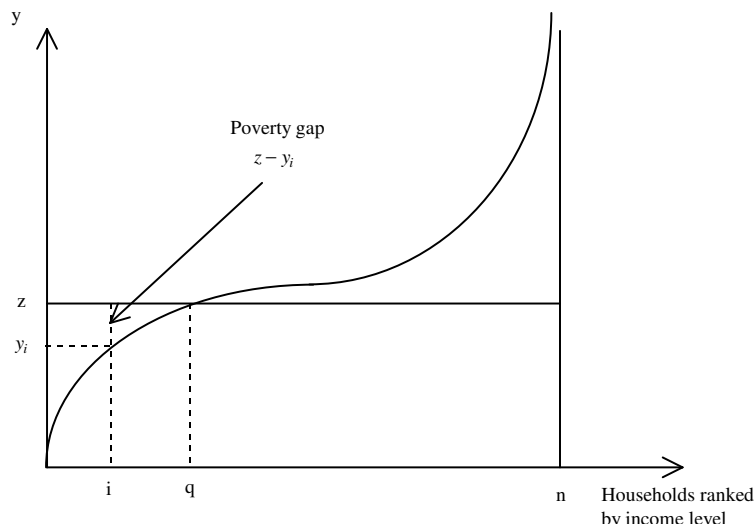


Figure 2. Poverty profile

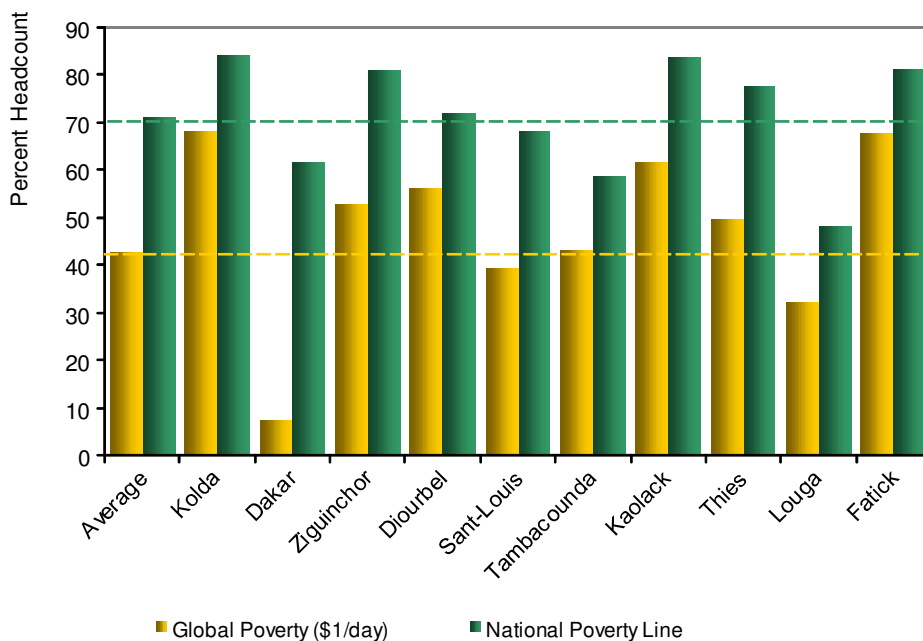


Figure 3. Poverty headcount by province, Senegal 2001

The last livestock poverty indicator we consider, LDI1.4, comes from a larger class of income and expenditure share indicators developed by Kuznets and others. Here we consider the share of total consumption for the poorest quintile of the reference population. When looking at the same reference groups, this indicator will always be less than 20 percent, assuming the poor lack access to credit that would sustain aggregate consumption above their income levels. When we compare provincial consumption shares to shares of national income, however, a wider range of outcomes is possible as can be seen in Figure 7. This diagram shows the per-cent of total provincial consumption represented by the poor, measuring the latter group by income quintiles at the provincial (yellow that is, using sub-national poverty lines) and national levels (green).

These results give interesting insight into patterns of poverty. For example, using provincial income quintiles indicates, as intuition would suggest, that the poor are seriously constrained in discretionary spending. On average, their spending only represents about 11 percent of national consumption, about half their population share. When applying national standards for income, a more complex pattern emerges. Poor populations, because of greater aggregate local purchasing power, are much more influential as a consumer group in rural dominated provinces. In Kolda, Kaolack, and Fatick, for example, consumption by the poor (by national quintile) expenditure exceeds 20 percent of provincial expenditure. In Dakar, by contrast, spending by the urban poor is dwarfed by that of higher income groups.

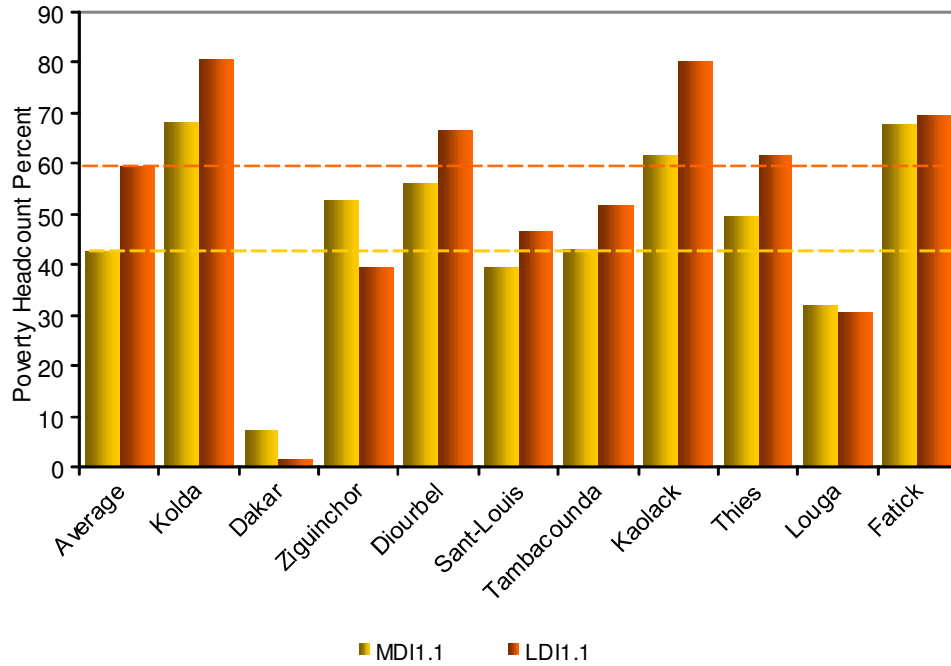


Figure 4. Overall and livestock dependent poverty headcounts, Senegal global poverty Lines.

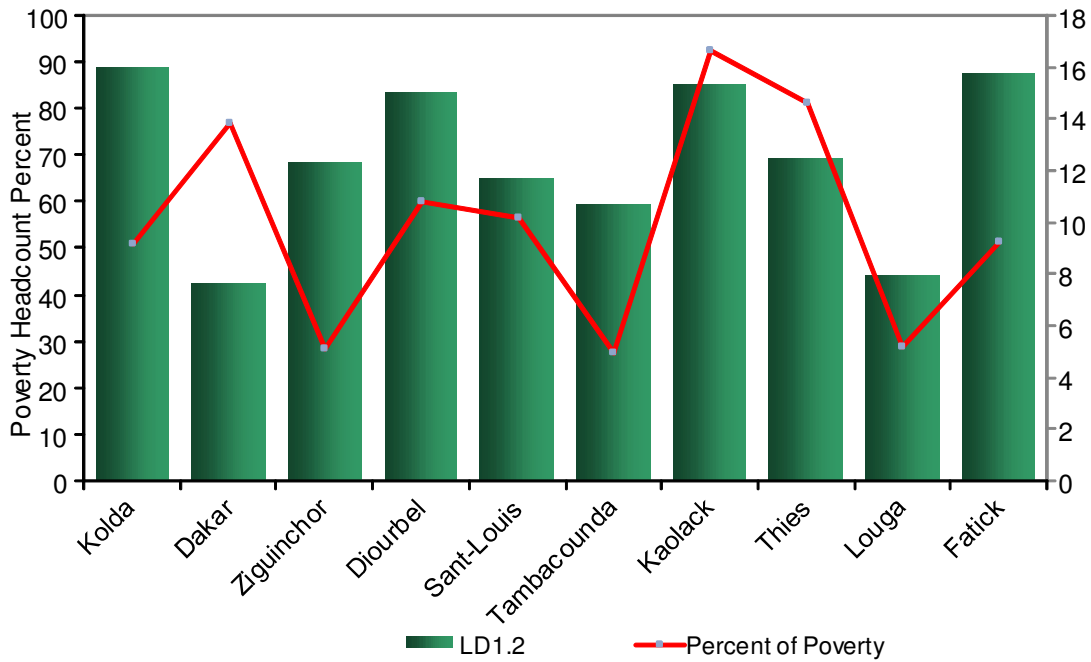


Figure 5. Livestock poverty headcount and density by province, Senegal national poverty lines.

How do income-consumption comparisons differ from a livestock perspective? Insight into this question can be gained by examination of Figure 8, which compares provincial quintile measures with and without LD weighting. The most arresting feature of these results is of course the much lower consumption shares for the livestock dependent. It is tempting to interpret this indicator adversely, yet the low numbers represent both disadvantages and advantages

for LD households. Firstly, they are certainly over-represented among the poor, as has been apparent throughout the analyses. However, LD households are also more subsistence oriented, which makes them less dependent on consumption of marketed commodities. Advantages of the latter include lower consumption price risk, greater capacity for saving as a percent of income, and a host of social capital attributes that are difficult to quantify.

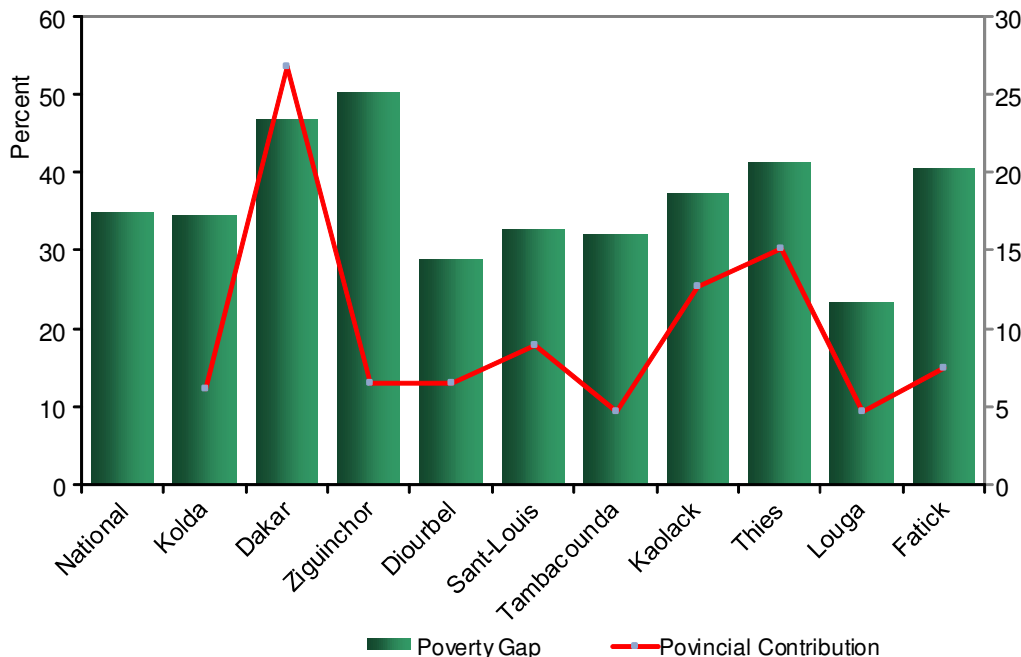


Figure 6. Poverty gaps at the national and provincial levels.

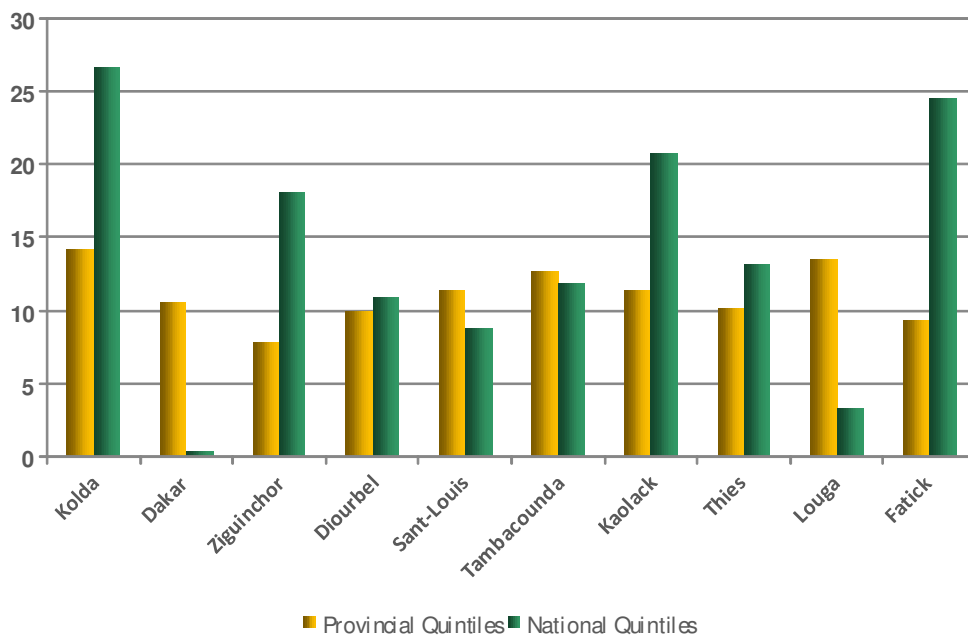


Figure 7. Consumption shares of the poorest income quintiles

Having said this, it is unlikely that the market isolation advantages of subsistence outweigh the disadvantages of lower income. The fact remains that LD populations have much lower average incomes in Senegal than the general population, and especially so among the poorest quintile, whether defined by national or provincial standards (Figure 4). Recall also that livestock products constitute only a fraction of total consumption, so the consumption shortfall of the LD population can only be fractionally explained by own food pro-

duction. The more likely inference is that LD populations are economically marginalized, with very low formal sector income and commensurate access to marketable consumption goods. From this perspective, livestock then reveals itself as a livelihood catalyst, an essential means to increase cash incomes and improve purchasing power for a group that is unusually deprived in this sense. Once again, targeting livestock can accelerate living standards progress because it targets income growth toward a population where the

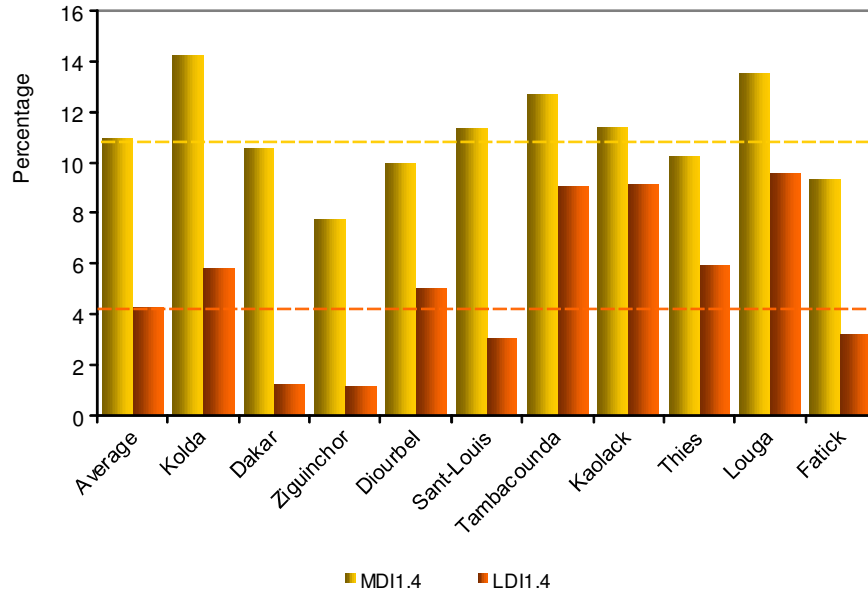


Figure 8. Consumption shares for provincial income quintiles, overall and LD population.

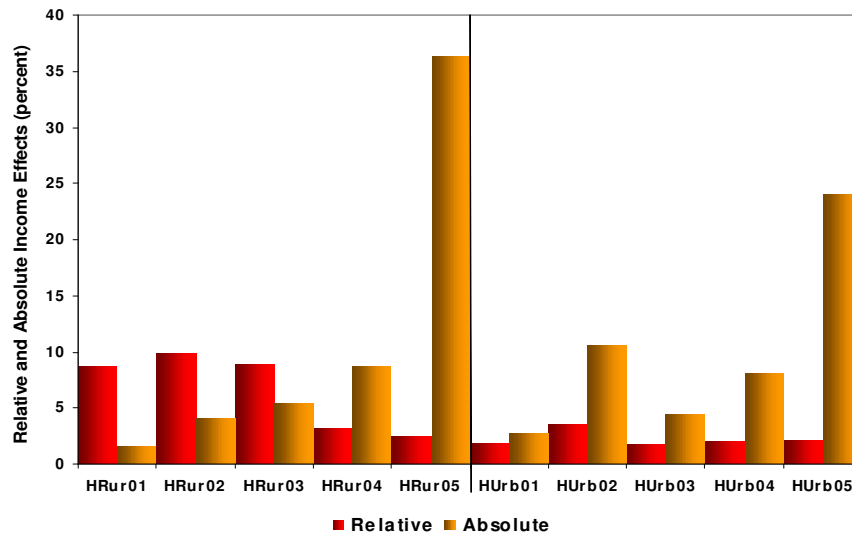


Figure 9. Multiplier linkages from livestock to Senegalese households.

marginal expenditure benefits are likely to be greatest.

Linkage analysis of the livestock sector

In most developing countries, the majority of rural income arises from marketing primary food products. Livestock’s contribution to this income depends on complex market supply chains extending from the farm gate to urban and even foreign households. Our research on these linkages indicates that the terms of this market participation are far from achieving their potential to help the rural poor. In particular, rural producers lack bargaining power and the information needed to invest in quality improvements, both of which would translate into higher direct incomes and, in most cases, national poverty alleviation.

To elucidate the market linkages that tie rural livelihoods to regional and national food markets, we used multiplier analysis with a new social accounting matrix for Senegal. This analytical resource

was developed for scenario analysis in IPALP and is discussed in more detail in the next section, while the Senegal Social Accounting Matrix (SAM) is more fully documented elsewhere.³ Suffice for the present to note that the 2001 Senegal SAM distinguishes rural and urban households by income quintile and also disaggregates livestock production, processing, and marketing from other economic activities.

Using this matrix with conventional multiplier methods, we find that linkages from livestock to Senegalese household incomes exhibit complex properties that depend on where households participate in the value chain of food production, beginning with livestock rearing and ending with retail sales of livestock products. In particular, Figure 9 reveals that the absolute income multiplier from livestock is

³ See Roland-Holst and Kazybayeva (2006). For background on SAM methodology, see Pyatt and Round (1982) and United Nations (1993).

Table 1. Senegal: Path decomposition for low income rural households.

Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HRur01	Lvst				1.6	77.2	77.2
	ProcMeat	Lvst				4.1	81.3
	Mill	Lvst				3.5	84.8
	OtProcFd	ProcMeat	Lvst			1.8	86.6
	Mill	ProcMeat	Lvst			1.6	88.2
	OtProcFd	Lvst				0.8	89
	HotelRest	ProcMeat	Lvst			0.7	89.7
Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HRur02	Lvst				4.1	81.5	81.5
	ProcMeat	Lvst				4.7	86.2
	OtProcFd	ProcMeat	Lvst			2.8	89
	Mill	Lvst				1.6	90.6
	OtProcFd	Lvst				1.3	91.9
	HotelRest	ProcMeat	Lvst			1.1	93
	Mill	ProcMeat	Lvst			0.7	93.7

largest for high income rural and urban households. HRur05 and HUr05 refer to the fifth (highest) quintile of the rural and urban population samples respectively etc. These groups are most likely to be engaged in downstream food supply activities, including food processing and retailing. While low income groups receive smaller absolute gains from the livestock value chain, however, the relative benefits to them (as a share of initial income, in red) are greater, particularly for low income rural households. This evidence further strengthens the case for livestock as a pro-poor policy instrument, since the marginal effect of improving livestock supply conditions will disproportionately benefit the country's rural poor majority.

To better understand the determinants of aggregate livestock-livelihood linkages, we used techniques of multiplier decomposition analysis. This approach, called path decomposition, unravels all the components of the value chain, including linkages to intermediate goods and factor markets.⁴ Complexity of these linkages makes the path approach very detailed, and we only summarize a few salient findings below.

Table 1 presents a path decomposition linking livestock to Senegal's poorest two rural quintiles households. In these tables, the Target column denotes the ultimate recipient of income flows. Each of the Sector columns allows for tracing multiplier chains across up to five sectors or other institutions. The Global effect is the composite multiplier effect on this beneficiary, and percentages of this are listed, incrementally and cumulatively, in the two right-most columns. As these results make very clear, the small absolute livestock-livelihood gain for the poorest comes almost entirely from direct production income. Both quintiles 1 and 2 get more than three-quarters of their livestock related income directly from animal (product) sales, and thus they leave the food value chain at the earliest stages. A very small component of indirect income can be obtained by selling to local processors, but it appears that most poor farmers sell only whole animals and raw animal products to market intermediaries.

The situation for rural middle income households in Senegal, summarized in Table 2, is a bit better in absolute terms, with Total multiplier gains two to three times higher. Having said this, however, the

patterns of income generation are similarly limited to direct animal production. Thus even the third and fourth rural deciles are confined to the inception point of the food value chain, with limited bargaining power and value added potential.

As the results of Table 3 make clear, higher income rural households have very little direct participation in livestock production. Despite this fact, they receive the largest absolute multiplier benefit from this agricultural activity, almost entirely indirectly from food processing and retailing. About half their livestock income arises from production of food services directly as business owners, and the rest comes from employment in the same sectors. These more complex downstream linkages to food value creation are the key to higher aggregate income gains for this group. This evidence has important implications for the net results of incomes policies. Higher income groups generally have more indirect linkages to livestock income. This means they may capture a large percentage of gains, even from policies targeted elsewhere.

Table 4 summarizes path results for lower income (second quintile) urban households. Note first of all their limited participation in direct production. Over two thirds of the benefits this group enjoys from livestock are indirect, coming from production and employment in food processing services. This is the primary way in which the urban poor participate in the food economy, and the indirect benefits they enjoy from livestock are non-trivial.

Policy simulation

The IPALP methodology includes a policy simulation component, permitting experimentation with alternative poverty alleviation strategies ex ante to gain a better understanding of their likely effects on poverty incidence. In the Senegal case, this takes the form of a dynamic CGE model that captures ten household categories and 35 production sectors. This model is used more intensively for research reported elsewhere, but in this section we summarize results of a few policy scenarios that have implications for the present discussion.

In particular, we examined policies with two generic objectives, to improve conditions of livestock production and to improve rural household market access. In the first case, we consider two producer-oriented policies, namely improvements in livestock productivity and

⁴ See Defournay and Thorbecke (1984) and Roland-Holst and Sancho (1992) for details.

Table 2. Senegal: Path decomposition for middle income rural households.

Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HRur03	Lvst				5.4	76.9	76.9
	ProcMeat	Lvst				6.1	83
	HotelRest	ProcMeat	Lvst			4.8	87.8
	OtProcFd	ProcMeat	Lvst			2.4	90.2
	Mill	Lvst				2	92.2
	OtProcFd	Lvst				1.1	93.3
	HotelRest	Lvst				1	94.3
	Mill	ProcMeat	Lvst			0.9	95.2
Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HRur04	Lvst				8.7	81.9	81.9
	ProcMeat	Lvst				6.5	88.4
	OtProcFd	ProcMeat	Lvst			1.7	92.7
	Mill	Lvst				1.1	89.4
	HotelRest	ProcMeat	Lvst			1.1	94
	OtProcFd	Lvst				0.8	90.2
	Mill	ProcMeat	Lvst			0.5	91

Table 3. Senegal: Path decomposition for high income rural households.

Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HRur05	Lvst				36.3	1.7	1.7
	ProcMeat	Lvst				28.9	30.6
	OtProcFd	ProcMeat	Lvst			6.6	37.2
	HotelRest	ProcMeat	Lvst			6.4	43.6
	PublServ	Labor	HUrb02	ProcMeat		3.9	47.5
	PublServ	Labor	HUrb02	Lvst		3.8	51.3
	PublServ	Labor	HRur01	Lvst		3.4	54.7
	PublServ	Labor	HRur02	Lvst		3.4	58.1
	OtProcFd	Lvst				3.1	61.2
	HotelRest	Lvst				1.4	62.6
	PublServ	Lvst				1.4	64
	Mill	Lvst				1.3	65.3
	Leather	ProcMeat	Lvst			1	66.3
	Silvc	Capital	HRur03	Lvst		0.9	67.2
	FoodCr	Lvst				0.7	67.9
	Silvc	Capital	HRur02	Lvst		0.7	68.6
	Mill	ProcMeat	Lvst			0.6	69.2
	Silvc	Capital	HRur04	Lvst		0.6	69.8
	FoodCr	Capital	HRur03	Lvst		0.5	70.3
	PublServ	Labor	HUrb02	OtProcFd		0.5	70.8

subsidies to capital that might facilitate innovation, efficiency and profitability. Specifically, we assume that productivity doubles over a ten year period in the first scenario and that a 20% subsidy is given for capital outlays in the second. Finally, a third scenario examines a generic case of trade liberalization for Senegal, with an assumption that the country unilaterally abolishes import protection.

The sample simulation results are presented in Figure 10 stated as percentage changes in real household incomes after ten years. Note first of all that the productivity scenario is the most stimulatory, with much greater gains for most income groups. An ironic but dramatic effect in this scenario is the value capture by higher income households, however. Although they have limited participation in

Table 4. Senegal: Path decomposition for low income urban households.

Target	<=Sector1	<=Sector2	<=Sector3	<=Sector4	Global	Percent	Total
HUrb02	Lvst				10.5	27	27
	ProcMeat	Lvst				27.1	54.1
	HotelRest	ProcMeat	Lvst			8.1	62.2
	OtProcFd	ProcMeat	Lvst			7	69.2
	OtProcFd	Lvst				3.3	72.5
	HotelRest	Lvst				1.8	74.3
	Textiles	Capital	HRur03	Lvst		0.7	75
	RealEst	Capital	HRur03	Lvst		0.7	75.7
	OilFats	CashCr	Lvst			0.5	76.2
	Leather	ProcMeat	Lvst			0.5	76.7
	Textiles	Capital	HRur02	Lvst		0.5	77.2
	RealEst	Capital	HRur02	Lvst		0.5	77.7

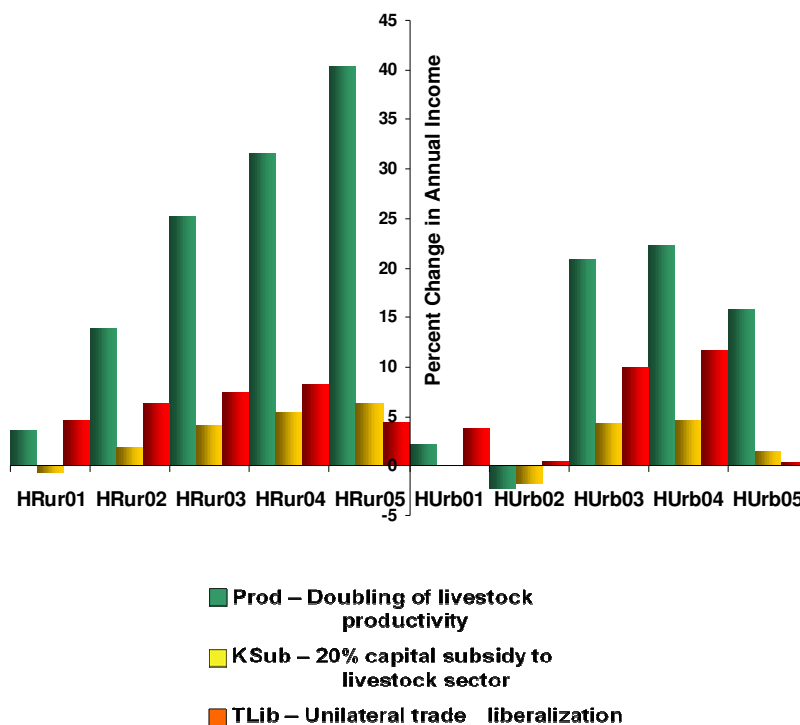


Figure 10. Simulations of producer support and trade liberalization: Senegal.

production, and the original (productivity enhancing) policy is production oriented, greater producer cost efficiency apparently translates into more intense competition among producers, transferring profitability downstream in the food supply chain. By contrast, capital subsidies are more modest, but more equal in their benefits. The poorest households, with little initial savings or capital, will not benefit, but middle income, more entrepreneurial producers could gain from increasing investment.

Finally, trade liberalization positive but modest effects across all ten household types. As intuition would dictate, urban populations are most affected, along with higher income rural households who

are more likely to be linked to external markets. Interestingly, trade is the most beneficial of the three policies for the poorest, although the absolute effect is modest in comparison to higher income groups. Lacking assets for enterprise development, in livestock or elsewhere, the poor benefit from the real income effect of lower prices for essential commodities. If the rural poor are to be effectively targeted, it appears that market access improvements should focus on local and regional markets. Investments in infrastructure can improve the rural terms of trade from two directions, reducing the cost of urban agricultural supplies and making rural farm products more competitive in urban markets. Finally, it is clear from these re-

sults that policies which strengthen rural household bargaining power in the supply chain will go further to raise incomes of the nation's rural poor majority. Generally speaking, higher income groups appear to be in a position to capture most of the gains from generalist policies, so targeted approaches will be needed for more effective poverty alleviation.

Conclusions

Livestock is an essential asset to the rural poor, both to those directly engaged in agricultural production and to poor non-farm rural households who rely on local production for affordable nutrition. Animal production confers many economic advantages on small farm operations, and in an era of rising urban incomes and improving market access animal products have increasing potential as marketable commodities. If small farmers can more effectively participate in local regional, and even larger food markets, national growth can contribute significantly to livelihoods of the world's poor rural majority.

In this report, we present a series of empirical techniques to study linkage between livestock and livelihood, using data from Senegal, a West African economy with high levels of smallholder poverty and livestock dependence. Our results for this country show that livestock dependent populations are more likely to be poor and the severity of their poverty is greater, yet the same reliance on livestock also offers a way out of this adversity. By analyzing market linkages and supply chains in the livestock sector, we find that rural household producers capture only a small fraction of the ultimate value of their products. Moreover, we find that generalist agricultural promotion policies may be of limited value because most of their value can be captured by downstream market participants. Our basic conclusion is that livestock holds substantial potential for poverty alleviation, yet carefully targeted policies is needed to realize this potential.

Livestock can make a substantial contribution to poverty reduction, but pro-poor policies need targeting. Effective, market oriented livestock promotion has significant potential to:

- Increase output quantity, quality, and prices
- Reduce cost with improved production and distribution technology

In Senegal, policies achieving the above can sharply improve the terms of market participation for smallholder producers of animals and animal products, who currently receive only a small fraction of the ultimate value of their output. It is essential to emphasize, however, that this is not a zero-sum bargaining problem. In addition to redistributing value along the supply chain, greater market integration for smallholders can increase valuations at all stages. By improving product quality, reducing perishability, and reducing inventory and distribution costs, rural incomes can rise along with profits at every step in the food value chain.

REFERENCES

- Defourny J, Thorbecke E (1984). Structural Path Analysis and Multiplier Decomposition within a Social Accounting Matrix, *Econ. J.*, vol. 94: 111-136.
- FAO (2002). FAO Methodology for Estimating the Prevalence of Undernourishment, Proceedings of the International Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition, Food Insecurity and Vulnerability Information and Mapping Systems, Food and Agriculture Organization.
- FAO (2005). The State of Food Insecurity in the World, Food and Agriculture Organization, Rome.
- Kazybayeva S, Roland-Holst D (2006). A social accounting Matrix for Senegal. Internal PPLPI Working Document, FAO, Rome.
- OECD (2005). International Development Statistics (CD-ROM). Organisation for Economic Co-operation and Development/Development Assistance Committee (www.oecd.org/dac).
- Roland-Holst D, Otte J (2006). Livestock Development Goals: Definitions and Measurement. Internal PPLPI Working Document, FAO, Rome.
- Pyatt G, Round J (1985). *Social Accounting Matrices: A Basis for Planning*. Washington, DC: The World Bank.
- Roland-Holst D, Sancho F (1992). Relative Income Determination in the United States: A Social Accounting Perspective. Review of Income and Wealth, Trade Analysis and Information System (CD-ROM), United Nations Conference on Trade and Development. 38: 311-27
- UN (1993). System of National Accounts, United Nations, Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank, Series F, no. 2, rev. 4 (United Nations publication sales no. E.94.XVII.4, para. 7.66), for import duties.
- UN (2001). Indicators of Sustainable Development: Guidelines and Methodologies. United Nations Division for Sustainable Development (www.un.org/esa/sustdev/natlinfo/indicators/isd.htm).
- World Bank (2005). World Development Indicators. World Bank (www.worldbank.org/data).