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Livestock development planning in Uganda: Identification of areas of opportunity and challenge

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ABSTRACT

Livestock are an important element of the livelihoods of many Ugandan households, and considerable efforts at economic development by the government of Uganda have focused on the livestock sector. However, these development efforts have suffered due to a lack of detailed data on the distribution of livestock in Uganda to guide the targeting of such programs. In this paper, we use data from the 2008 National Livestock Census to develop a better understanding of where in Uganda there might be potential for significant investment to intensify the production of livestock and, conversely, where there are important challenges that need to be addressed, such as conflicts between human populations and livestock. This analysis is done by developing a quantitative model to predict mean livestock stocking rates at sub-county level ($n = 929$) that uses population density, agroecological factors, and market access as explanatory variables. A mapping of model residuals approach is then used to identify areas in Uganda that are relatively understocked and those that are potentially overstocked. This information is used to suggest approaches to livestock development in both types of areas.

Introduction

Livestock are an essential agricultural resource for Uganda. Uganda's populations of cattle, goats, and poultry are among the highest among African countries – generally estimated to be in the top quintile.[2] Nomadic pastoralism constitutes the principal livelihood for many households in the northeastern part of Uganda. The landscape of the so-called cattle belt, stretching across the middle of Uganda from the base of the highlands in southwestern Uganda through the area around Lake Kyoga to northeastern Uganda, is characterized by extensive cattle-dominated farming systems. Intensive livestock production is common in areas with higher population densities, with dairy cattle ownership being an important characteristic of economically progressive farmers in these zones. Investment in intensive poultry production, both layers and broilers, over the past 15 years has become increasingly common in periurban areas of Uganda. Pork production is now expanding quickly in the same areas. Seventy percent of Ugandan households are engaged in some form of livestock rearing (MAAIF and UBOS, 2009).

Although crop agriculture generally receives more attention than livestock in the development programs of the government of Uganda, livestock are part of the vision of Uganda's leaders for economic development and poverty reduction. Livestock are given attention in Uganda's *National Development Plan (2010/11–2014/15)*, which seeks annual growth of 5.4 percent in the sector, up from an average of 3.0 percent in recent years (NPA, 2010). Beef and dairy cattle and poultry are identified as strategic agricultural commodities for the country that are to receive increased investment levels for accelerated production. Efforts continue to restrict the distribution of tsetse fly and control trypanosomiasis across Uganda. Since independence, considerable public investments have been made in ranching schemes (in the 1960s in western Uganda), animal disease control, and livestock markets. However, many of these investments were planned without sufficient understanding of the opportunities for and constraints to livestock development nationally. A principal reason for this has been the lack of good estimates of the distribution of livestock and of the prevalence of livestock ownership across Uganda.

In February 2008, the National Livestock Census was carried out across Uganda. The livestock census – in reality, a large sample survey – involved interviewing approximately 950,000 households

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2 Livestock population statistics for 2010 from the Food and Agriculture Organization show Uganda having the 11th largest national cattle herd, 10th largest national goat herd, and 16th largest national chicken flock among all African countries (FAO, 2012).

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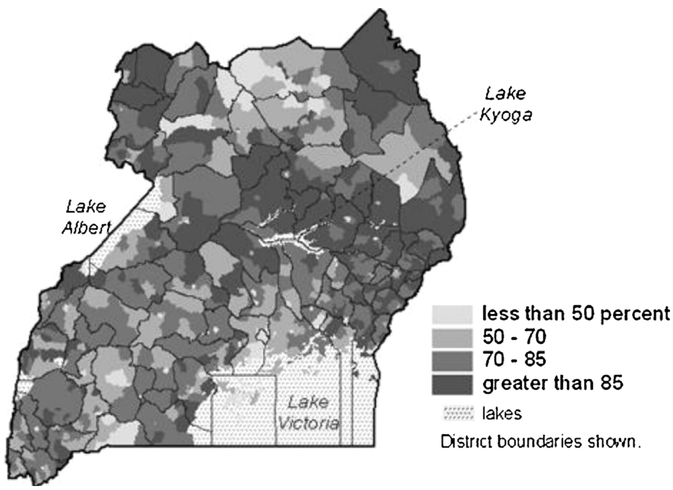

Fig. 1. Uganda 2008 National Livestock Census results: percentage of households rearing livestock, by sub-county.

in almost all sub-counties across the country concerning their livestock ownership and livestock-related activities. With the publication of the statistical abstract from the livestock census in May 2009 (MAAIF and UBOS, 2009), livestock development program designers and implementers now have a significant source of detailed information on livestock to use as evidence to guide their planning activities (see Fig. 1).

We use data from the 2008 National Livestock Census to investigate where in Uganda there might be potential for significant investment to intensify the production of livestock and, conversely, where there are important challenges that need to be addressed, such as conflicts between human populations and livestock. This analysis is done by developing a quantitative model to predict mean livestock stocking rates, expressed as tropical livestock units (TLU) per square kilometer, at sub-county level ($n = 929$) using population density, agroecological factors, and market access as explanatory variables. This model is estimated using a spatial regression technique – a spatial error maximum-likelihood estimation model – that controls for spatial autocorrelation in our dataset. We then use an exploratory data analysis method for spatial data, the mapping of the model residuals, to identify sub-counties whose observed livestock stocking rates are much lower than the model predicts and those whose observed stocking rates are much higher than the model predicts. Those areas where the model predicts much lower stocking rates than are actually found likely are overstocked and are candidate areas to target programs that promote more intensive, land-conserving livestock production methods or even destocking. In contrast, those areas where the model predicts much higher stocking rates than are actually observed are candidate areas for targeting programs aimed at enhancing livestock production through, among other things, increasing the livestock population there. As this analysis is done at the broad, national scale, further local-level studies will need to be done to confirm the results presented here. However, this study provides initial guidance on areas of opportunity and challenge for livestock development in Uganda.

Analytical methods

Two analytical techniques are used in this study: (1) derivation of the quantitative model to predict mean livestock stocking rates and (2) mapping of the residuals from this model.

Modeling mean livestock stocking rates

Our predictive model of the mean TLU per square kilometer across 929 sub-counties in Uganda relies upon a small set of explanatory variables: population density, agroecological factors, and market access.[3] An ordinary least square (OLS) regression procedure would be the standard way to develop such a multivariate model. However, livestock stocking densities in Uganda are strongly positively spatially autocorrelated. That is, the TLU per square kilometer for a particular sub-county is closely correlated with the TLU density of neighboring sub-counties – that is, sub-counties with high TLU densities form spatial clusters, as do sub-counties with low TLU densities. The spatial clustering of the relative intensity of livestock production stems from neighboring sub-counties sharing a similar comparative advantage (or disadvantage) for livestock production due to common agroecological conditions, level of access to livestock markets, and intensity of competing land uses, primarily. In consequence, one of the underlying assumptions of the OLS regression model, that the error terms for each observation are not correlated with one another, is violated, and the statistical interpretation of the results will be inefficient at best, biased and erroneous at worst (Kennedy, 1985).

Consequently, this spatial dependence usually is controlled for by using a spatial regression model that controls for the correlation with neighboring observations in the dependent variable – in the case of the analysis here, the strong correlation between the mean TLU value for a particular sub-county with mean TLU values for neighboring sub-counties. A variable representing this spatial dependency of the dependent variable, called a spatial lag variable, is inserted into the model as a supplementary explanatory variable. The most common way in which this is done is to use the spatial lag of the dependent variable. In the case presented here, the spatial lag variable for each sub-county in our dataset is the weighted mean of the TLU density for neighboring sub-counties. How large of a neighborhood of sub-counties is used to compute the spatial lag variable is a component of the analysis, as will be discussed in the presentation of results later.

The spatial dependence in the regression model can be conceptualized as being manifested in two different ways: as a spatial lag or as a spatial error. For the spatial lag, the spatial dependence can be judged to be a direct effect of the livestock stocking density in neighboring sub-counties on the stocking density in a particular sub-county in question. For the spatial error manifestation, the error term for the model in a particular sub-county is correlated with the model error terms of its neighbors, as might occur due to a missing spatial variable for the model that affects a particular sub-county and its neighbors in a similar manner. If uncorrected for, the implications of the effects of these two manifestations of spatial autocorrelation in an OLS base model differ. Where spatial lag dependence is shown, the estimated coefficients in the OLS model will be both biased and inefficient. In the case of spatial error dependence, the estimates will not be biased, but they will be inefficient, making interpretation of the significance of the results difficult. However, although they result from different interpretations of the spatial processes accounting for the spatial autocorrelation in the model, in practice there is usually very little difference between the two spatial models. In order to choose which one to use, the

[3] There likely is endogeneity in our model specification. For example, the livestock population potential of an area could as well be a determinant of human population density there as the reverse. While there are econometric methods to control for this sort of simultaneity between dependent and independent variables, since the objective of this modeling of livestock stocking densities is prediction rather than explanation, they are not employed here.