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FARMER'S RESOURCE FLOW DECISIONS ON FARM-LEVEL INTERVENTIONS ON LIVESTOCK WATER PRODUCTIVITY: A CONCEPTUAL MODEL APPROACH

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ABSTRACT

Across sub-saharan Africa water related poverty occurs because farmers lack dependable water resources and capacity to use them. Improvement in agricultural water management offer opportunities in poverty alleviation at farm-level. An integrated framework was developed to identify sets of options as interventions for different farmer profiles in mixed crop-livestock systems. A combination of participatory rural appraisal (PRAs), household survey and gap analysis tools were used in Nkayi district, Zimbabwe to quantify the current crop and livestock production levels. The tools used identified gaps in animal health management, improved feeding, livestock sales and poor crop yields between different farmer wealth profiles in terms of mortalities, poor crop yield, reduced crop and livestock sales, poor feed quality and quantity. Interventions in terms of improved feed sourcing, improved animal health, soil fertility management and access to markets are possible solutions to the challenges faced by the different farmer profiles. If farmers' different levels and capacities in terms of resources available are taken into consideration, there is a chance to improve the livestock water productivity at farm-level in semi-arid Zimbabwe.

Key Words: *mortality, interventions, gap analysis, participatory rural appraisal.*

1. INTRODUCTION

Across wide tracts area of semi-arid Sub-Saharan Africa (SSA), water scarcity is a major factor limiting agricultural production for millions of resource-poor dry land farmers (Molden et al., 2003). Water related poverty occurs because people lack dependable water resources and capacity to use them. Improvement in agricultural water management offer poverty alleviation through increase in water productivity at the field, farm and landscape level by removal of production constraints (Cook et al.,2006). More food and other agricultural products must be produced, with a minimum amount of water available. This has become a critical concern, especially for integrated crop –livestock farming system, which is the most common form of land use in semi-arid Zimbabwe. In these cases, in order to sustain livestock production, there is need to increase livestock water productivity (IWMI, 2000). Growing more feed using less water will make more water available for other uses. Gaining more yield and value from water will increase the water productivity, limit environmental degradation and ease competition for water. Better management in terms of feed sourcing, livestock rearing and soil and water conservation plays a key role in improving livestock water productivity.

Crop-livestock production systems are complex and therefore an integrating framework can help to identify sets of options to enable more effective and sustainable use of water. Many synergies in crop-livestock systems have been identified, e.g. livestock provide key inputs into crop production such as draught power, manure and transport. Conversely crop residues are important inputs to livestock production. Producing meat, milk and draught power typically requires more water than producing cereals-and a different style of water management (Molden et al., 2003). The water productivity in crop-livestock systems has however not been reliably determined. There is a great need to understand livestock and water interactions for improving livestock water productivity to shift water from unproductive use to productive use.

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This study uses a conceptual model approach to define questions and concepts more precisely and generate new hypotheses as was done by Turner et al., 2004. The models will cover farm and landscape scales, identify gaps within the scales and analyze interactions between the scales. They will identify the scale at which management decisions may be most effective. For example at the farm scale, information on drinking requirements of domestic animals exists, and it is known that water required for producing animal feed far exceeds what animals drink, and this varies greatly across agricultural production systems (Passioura, 2004). However, at the landscape scale the impact of livestock keeping on water resources has not been adequately synthesized and applied to integrated natural resources management concepts. Degradation of land and water resources by livestock is significant, and the expansion of croplands or allocation of water points may have negative implications on rangelands. Furthermore, an analysis is required to identify the incidence and depths of poverty associated with attributes of water distribution and management. There is a need to provide a better understanding in how far resource poor as compared to better off households can improve their livestock water productivity (Cook et al., 2006).

This paper is based on the livestock water productivity framework developed by Peden et al. (2007). It focuses on how current farm level interventions can improve water use in Nkayi crop- livestock systems, and how limited water resources can be safeguarded at the farm-level. The paper will also seek to evaluate potential entry points for technical options to improve water use efficiency and will also identify gaps for improved water saving options in livestock production.

2. METHODOLOGY

Data were collected through a combination of Participatory Rural Appraisals (PRAs) and two household surveys. A gap analysis process was also used to address the issues affecting each wealth category in the different areas of Nkayi.

3.1 Study Site

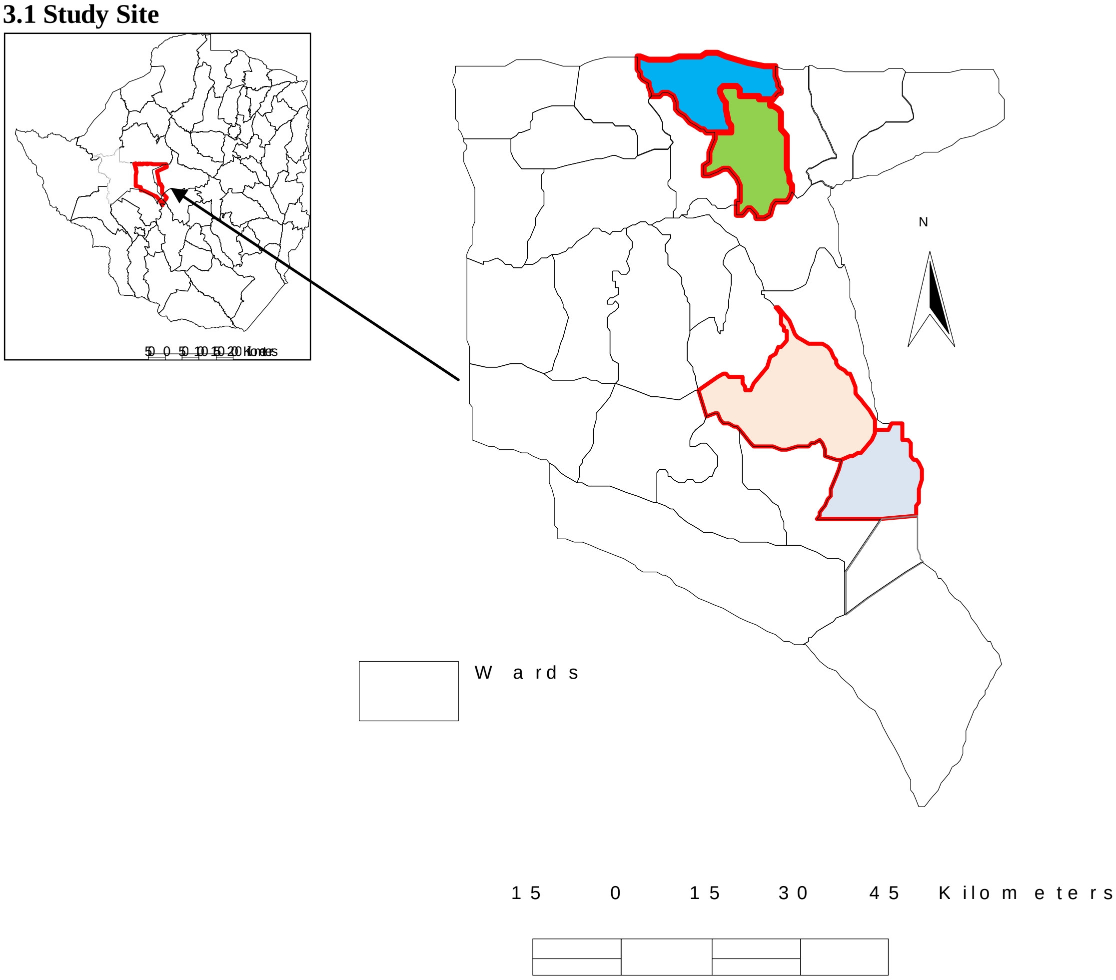

Figure 1: Study sites in Nkayi District

The study was carried out in Nkayi district of Matabeleland North province in Zimbabwe. This district has a mixed crop livestock land use system and lies in natural region IV with some pockets of Natural Region III. It is characterized by unreliable rainfall that ranges between 450mm to 650mm per annum. Besides the high human population density per km^2 (249 compared to 181 for Tsholotsho and 118 for Gwanda districts which are also in the semi arid regions), Nkayi has a higher potential to improve water productivity by its significant biomass production of fodder and crop residues that can be used to feed livestock during the dry season (Homann et al., 2007).

2.2 Sampling procedure

For this study the district was purposively stratified into two distinct areas that are the North and the South because of the ecological and socio-economic difference between these two areas. Population density in the North is lower, rangelands in better conditions but market access is poorer than in the South. Two villages were purposely selected from each of these two areas, and one site was attached to an irrigation scheme and the other not. Thirty households were then randomly selected from each of these villages bringing the total number of participating households to one hundred and twenty.

3. RESULTS

3.1 Comparisons of resource holding between different wealth groups

In this study we investigate small holder farms resource flow as affected by farm wealth group (Table 1). In the study area we observed that there was no significant differences between the different wealth groups on the size of the land and land allocated for the different use ($p<0.05$); except for maize, where the better-off had significantly more land for maize production than the poor-resource farmers ($P<0.05$). Unlike for land ownership the ownership of different livestock species showed significant differences between the two wealth group (better-off and resource-poor farmer). We observed highest differences for the bovine holding than the shoats (small ruminants; Table 1).

In terms of livestock dynamics we looked at the inflow and the outflow of the different livestock group and compared between the different wealth categories (Table 1). Accordingly we observed no significant differences between the different wealth categories for cattle inflow. Similarly there was no significant differences statistically for some outflow type (e.g sale and lost/strayed). The only herd dynamics differences observed were that the better-off farmer slaughtered significantly higher number of animals and lose more from mortality in absolute terms but the proportion is higher in resource poor farmers ($p<0.05$).

Table 1: Land and livestock holdings, inflows and outflows of Nkayi for the different wealth categories

Wealth group	n	Total land (ha)	Fallow land (ha)	Maize land (ha)	Sorghum (ha)	Millet land (ha)	Bovines (TLU)	Shoats (TLU)	Births	Mortalities	Slaughters	Sales
Better-off	n=32	3.71	1.13	1.96	0.19	0.09	12.24	0.8	0.97	1.28	0.031	0.063
Resource poor	n=74	3.94	0.59	1.71	0.31	0.03	3.63	0.35	0.58	0.27	0.014	0.027
Nkayi		3.83	0.86	1.79	0.27	0.05			0.68	0.887	0.019	0.037

Better-off farmer ≥ 7 cattle, poor resource farmer ≤ 6 cattle.

There were no significant differences between farmer wealth categories ($p>0.05$) in terms of total land sizes and land that is fallow. Land set aside for specific crop cultivation was similar except that better-off farmers cultivated significantly more maize land than the poor-resource farmers. In Nkayi, 98% of the farmers do not own land for livestock grazing. In terms of land for crop cultivation 8.5% have no land whilst 84% own at least one hectare. 97.2% of the farmers have land for gardening while 73.3% have no idle land and 22.9% have at least a hectare idle.

3.2 Conceptual resource flow models in crop-livestock system at the farm level

There are similar fundamental principles of resource flows in water limited crop-livestock systems. But from our observation it was apparent that there were differences in magnitudes of flow and constraints limiting the positive impacts of the flow. Figures 2 and 3 below give details of these differences. Various conceptual resource flow models were developed comparing different better-off and resource-poor farmers in the study site.

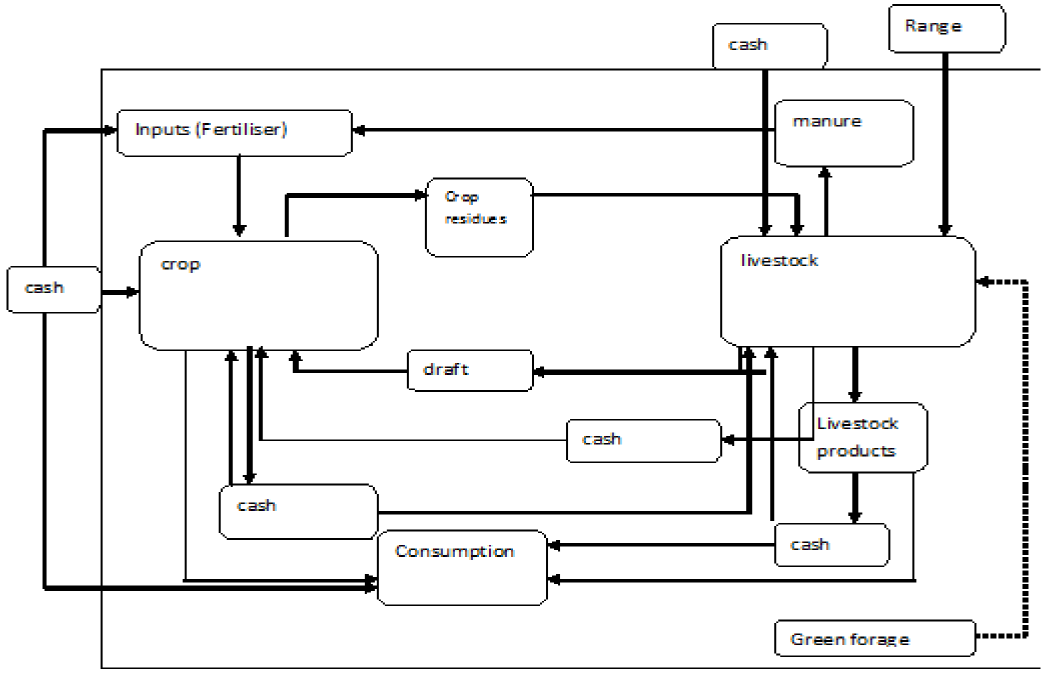

Figure 2: Conceptual model for resource flows for a resource-poor farmer

The key challenges indicated on the frameworks were high rates of livestock mortalities (17.4%), feed shortages and plant poisoning, no sales due to small herd sizes, no sales in terms of crops and consumption of both livestock and livestock products is poor and a challenge.

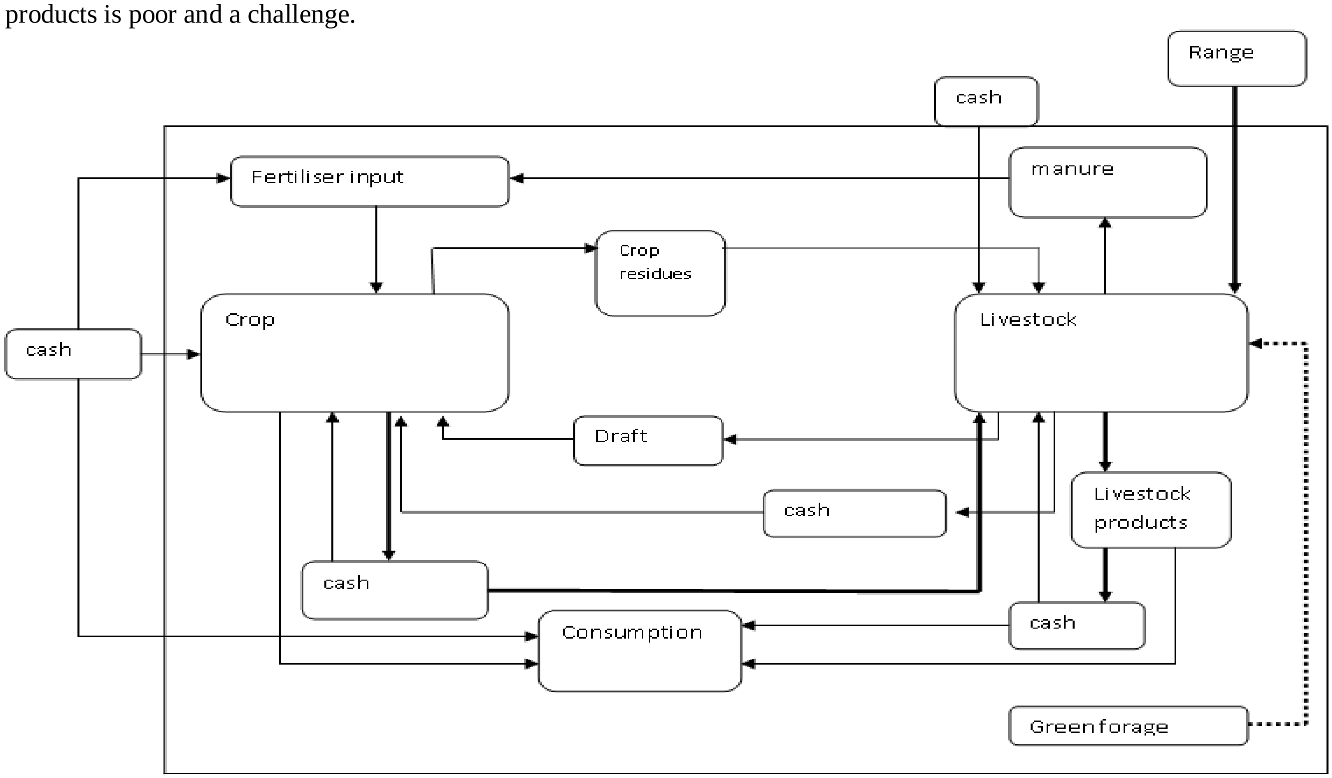

Figure 3: Conceptual resource flow model for a better-off farmer

In the model on figure 3 there are small herd sizes as compared to the resource poor farmer in the south, mortalities are a big challenge, sales are low due to poor access to the market, the little they get they sell to the neighboring farmers. They sell cash crops mainly cotton, feed and fodder is poor, and there is no treatment of stover. Consumption of both crops, livestock and livestock products is poor.

4. DISCUSSION

Usually grazing lands are communally owned, all farmer wealth categories responded that they supplemented natural pasture grazing with crop residues but this differed in terms of percentages. In general in this area, the impact of access to resources on water productivity lies mainly in the capacity of farm households to invest in different production factors, such as fertilizers, time of planting and appropriate crop selection that can increase biomass, this agrees with what (Haileslassie et al., 2006a, 2007) found out. Decisions made on interventions should take into cognizance the different farmer wealth categories, rather than assume that communities are homogeneous and incentives may drive farmers to act different in terms of improving the livestock water productivity. Generally, biomass productivity by the better-off farmers can be accounted for by better access to resources, which can help them to select cash crops, use inputs like fertilizers. Also they can use their higher labour force which is in terms of draught to ensure timely weeding and tillage. Land use and choice of crops depends on the wealth status and also determines the next crop to be planted for reasons of nutrient optimization and pest control.

The low livestock sales that were similar for better-off and poor resource farmers in the study were due to the fact that cattle are closely linked with crop production in small holder crop-livestock farming systems of Zimbabwe, so they are rarely disposed of. This is in agreement with the results found by Scoones (1990), which showed that cattle in communal areas are usually retained for their input into crop production as draught power and manure rather than their terminal benefit of cash and meat. Slaughtering of cattle is quite often done as a last resort to either salvage meat from an already dying animal or when farmers are under pressure such as at funerals and social gatherings. However in this study the consumption is higher amongst poor-resource farmers due to lack of alternatives for food. Cattle were sold to meet critical family needs such as school fees or when disposing of old and unproductive animals. Livestock sales from the communal herd could be significantly improved if farmers were encouraged to use highly nutritive feed, in terms of feed and fodder, treated crop residue. Making market availability for ease access to farmers would encourage poor resource farmers to improve on their livestock herd and flock sizes. For this to succeed there is a need to incorporate forage production into the farming systems so as to supplement the working oxen and the reproductive cows.

5. CONCLUSIONS

An integrated framework for crop-livestock systems is critical to evaluate interventions which are sustainable at a system level, The poor crop yield in these systems can be improved through combining the use of manure with mineral fertilisers. By doing so the rates at which manure needs to be applied (amount of manure per unit area of land), is much reduced. However, most mineral fertilizers have to be purchased, requiring one to spend more money which could be a challenge to the resource constrained farmer. However, this can easily be feasible for the better-off, because through their livestock sales they can plough back the returns into the crop production system as seen in the resource flow framework for the better off farmers. In order to enhance crop productivity in water-limited environments, there is a need to evaluate and apply water-saving management practices. This analysis has implications for improving crop water productivity under dryland and limited water scenarios. Analysis is required to identify the incidence and depth of poverty associated with attributes of agricultural water management, and to provide a richer understanding of the nature of poverty and the degree to which it can be alleviated through improved agricultural water management. This is a necessary step for devising evidence-based, targeted interventions (Cook et al., 2006).

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