

Full Length Research Paper

Institutional factors and governance arrangements affecting crop residue utilization in Mt. Elgon Region, Uganda

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Crop production in Mt. Elgon region (Uganda) generates a significant amount of crop residues (CR) that have for a long time been considered as ‘trash’ or agricultural waste. This neglect is due, in part, to the absence of a clear institutional framework governing utilization of CR. This paper presents a case for understanding of institutions that govern practices of CR utilization. It adopts the Institutional Analysis and Development framework to trace the evolution of institutional mechanisms governing utilization of CR; review the role of current institutional arrangements in influencing CR utilization among farming households; and recommend options that bolster household actions towards the utilization of CR. A synthesis of colonial institutional frameworks including bylaws showed that farmers were encouraged to engage in several soil conservation practices. Strict enforcement of these laws weakened after independence and almost collapsed with successive regimes. There is still a lack of an appropriate institutional framework at local level to influence the utilization of CR in Mt. Elgon region. The paper argues that proper institutional frameworks that penalize improper land use and incentivize better land use practices; build the capacity of farmers through awareness raising programs; and encourage better technologies for CR handling and storage should be strengthened.

Key words: Crop residues, policies, smallholder farmers, Mt. Elgon Uganda.

INTRODUCTION

In rural areas of sub-Saharan Africa (SSA), most people depend on agricultural production for their livelihoods. In

the last three decades, numerous advances have been made in agricultural research and technology generation

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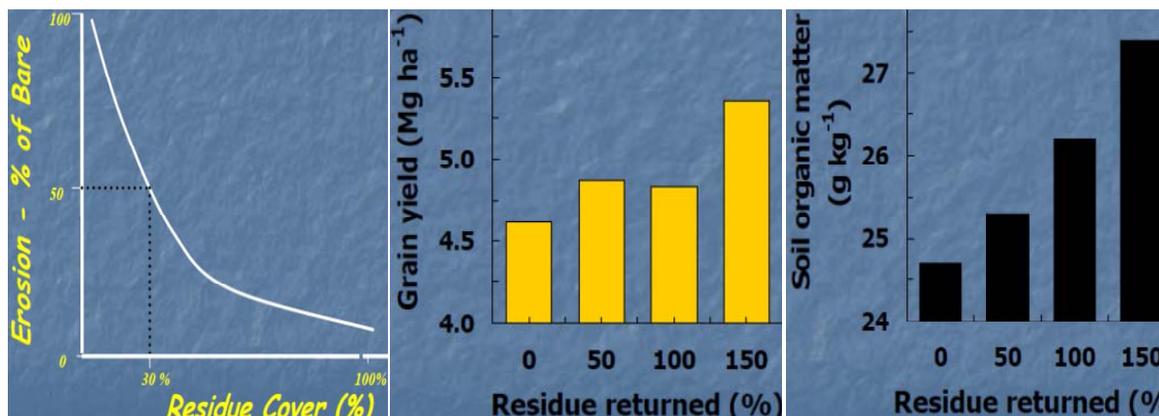


Figure 1. What effects do residues have on soil erosion, grain yields and soil organic matter? Source: Laflen and Colvin.1981, 607 and Karlen, (n.d), 13.

for increasing agricultural productivity in SSA, and for ensuring sustainable use of scarce natural resources (Njuki, et al., 2008). In Uganda, fertilizer use is still very low and mainly restricted to use on estate crops like sugarcane and tea and on high value crops like flowers. Smallholders have used fertilizers mainly on tobacco, cotton, and vegetables in peri-urban areas and in a few cases on coffee. Total fertilizer use in Uganda peaked in 1971/72 at 27,000 metric tons (MT) before dropping to virtually zero in the 1980s (Roy and Nabhan, 2001). Overall average fertilizer use is still less than 1 kg/ha per farm family per year, compared to 15 kg/ha per farm family per annum reported for other sub-Saharan African countries and its used is mainly confined to large-scale farmers and estates and applied mainly to cash crops (IFDC et al., 2000). An integral part of sustained poverty reduction efforts is improved soil management and sustainable use of natural resources (Nkonya et al. 2004) and the potential role of crop residues should not be underestimated in this regard.

Soil scientists, are quick to point out that these residues currently serve a function on the farm; when left on fields, they help reduce erosion and its associated water-quality impacts, build up the soil's productivity through increased organic matter and nutrients, and sequester carbon that might otherwise be released into the atmosphere as a greenhouse gas. Crop residues are important in the formation of soil organic matter (SOM). In addition, residue buffers soil against the forces of raindrop impact and wind shear and strongly influence radiation balance and energy fluxes and reduce the rate of evaporation from the soil (Wilhelm et al., 2004). Addition of crop residue plays an important role in soil organic carbon sequestration in improving soil structure, soil water-holding capability, and soil erosion prevention. Crop residue is important to soil nutrient cycling and soil

fertility. It was also estimated that residue contained 18 to 62 kg Mg⁻¹ of agronomically important nutrients, depending on the type of residue produced and its nutrient content, which would be equivalent to 83% global fertilizer consumption in 2001 (Lal, 2009 in Hou et al., 2011). Such residues currently replenish nutrients and protect soils (Okalebo et al., 1999), and their removal is unlikely to be sustainable unless accompanied by adoption of soil and water management practices such as no-till production, cover crops, and precision fertilizer management (Marshall and Sugg, 2008). Residues are important crop variables that influence runoff and erosion processes. The Water Erosion Prediction Project (WEPP) Hill slope model predicted that a 10% cover reduced soil loss and runoff by 32 and 28%, respectively. These roles of crop residues are also illustrated in Figure 1. However, adoption of soil management options needs to be accompanied by appropriate institutions and governance frameworks to improve agricultural productivity. While agricultural growth is regarded as a core sector of Uganda's economy in terms of its contribution to GDP and employment (NPA, 2010), clear and well-integrated national policies are required to increase productivity, improve rural livelihoods and facilitate the sustainable use of natural resources (Egulu and Ebanyat, 2000). Policies and institutions can therefore align incentives and create an enabling environment for improved utilization of crop residues and more broadly soil and water conservation.

There has been renewed interest in the use of crop residues in Uganda. Little information, however, is available on the extent to which smallholder farmers in Uganda use crop residues. It is very likely, however, that these resources are under-utilized. Even when they are utilized, farmers may not be able to incorporate them effectively year-round in their agricultural activities. Evidence in

Uganda suggests that the application of crop residues is the most widely practiced soil conservation measure (Yamano et al., 2004). In a study of national level utilization of soil improvement practices, Kraybill et al. (2012) found that the use of crop residue was popular as a soil improvement measure and the percentage of use increased from 27 to 58% from 2000 to 2007. Several studies suggest that crop residues have a potential role to play and are useful in the mitigation of land degradation including soil fertility restoration / maintenance and improvement and erosion control (Brinn et al., 2002; Tenywa et al., 2011); improving crop yields (Sseguya et al., 1999; Takashi, 2008; World Bank, 2005); act as feed resources for animal production (Bareeba and Mugerwa, 1987; Uganda Pasture Network, 1992); and are useful in bio-energy production (MEMD, 2001; Bingham, 2004 and World Bank, 2005). Other studies such as that of Masanza (2003) point to the fact that utilization of crop residues increases attraction and hosts acceptance of weevils. These studies are however, silent on the role that institutional factors play in enhancing the potential contributions of crop residues utilization in agricultural development.

The second part of the paper describes the Institutional Analysis and Development [IAD] framework, while the third part describes Mt. Elgon region; the setting in which the study was situated, respectively. This is followed in the fourth section by an explanation of the data and methods used in the study. Crop residue utilization exists in different forms, is variable across time and space, intersects/links several sectors and domains of decision-making, and conveys a wide range of socio-economic and political meanings. Institutional frameworks and governance arrangement that influenced crop residue utilization in the past are explored in the fifth section. The same section extends the discussion by looking at the current institutions or rules/norms/values at various spatial scales that govern the organization, policies and practices of crop residue utilization. Innovative policy options that would enhance the utilization of crop residues in the region are suggested in section six. Section seven ends with conclusions.

THE INSTITUTIONAL ANALYSIS AND DEVELOPMENT FRAMEWORK

Methodologically, the paper aimed to test how applicable the Institutional Analysis and Development (IAD) framework would be in Mt. Elgon regions. This framework is the collective product of the many and diverse social scientists who have participated in the Workshop in Political Theory and Policy Analysis (Polski and Ostrom, 1999) at the Center for the Study of Institutions, Population and Environmental Change (CIPEC) at the

Indiana University. The application of the IAD framework requires rich information on physical conditions of the region, existing rules and other attributes of the communities. The IAD framework has been developed to enable the analysis of 'institutional settings' – any situations that involve people interacting together in a certain context and following certain rules. The sets of rules relevant to any institutional setting are the institutional arrangements of that setting:

'An institution is simply the set of rules actually used (the working rules or rules-in-use) by a set of individuals to organize repetitive activities that produce outcomes affecting those individuals and potentially affecting others (Ostrom, 1992)'

Institutions may be formally described in the form of a law, policy, or procedure, or they may emerge informally as norms, standard operating practices, or habits (Polski and Ostrom, 1999). They include settled habits, are sets of common habits, routines, established practices, rules or laws that regulate the functional relationships and interactions between individuals and they are the working rules for going concerns. Institutions thus define and limit the set of choices individuals have; they can be created, as a set of incentives or rules for an organization, or they can evolve (informally) as part and parcel of patterns of action or culture. As routines or patterns of behavior in a work culture or social context, institutions explain processes of decision making, conduct and performance. Institutions create dissimilar *incentives* and *restrictions* for intensifying exchange, increasing productivity, inducing private and collective initiatives, developing new rights, decreasing divergence between social groups and regions, responding to ecological and other challenges. A part of the property rights, they are constituted by the *formal* laws, regulations, standards, court decisions etc. In addition, they are important *informal* rules determined by the tradition, culture, religion, ideology, ethical and moral norms etc. The *enforcement* of various rights is done by the state (administration, court, and police) or other mechanisms such as community pressure, trust, reputation, private modes, self-enforcement etc.

To understand the different rights that people have to land, it is conceptually and empirically useful to think beyond *ownership*, or ultimate control of land and the benefits that derive from that land. In practice, full ownership rights are rarely held by one individual or institution. Rather, it is more appropriate to think of *bundles of rights* that may be held by different holders of the rights. There are many ways to identify specific rights, but a useful classification used by Schlager and Ostrom (1992) includes:

1. *Access*: the right to be on the land, such as the right to

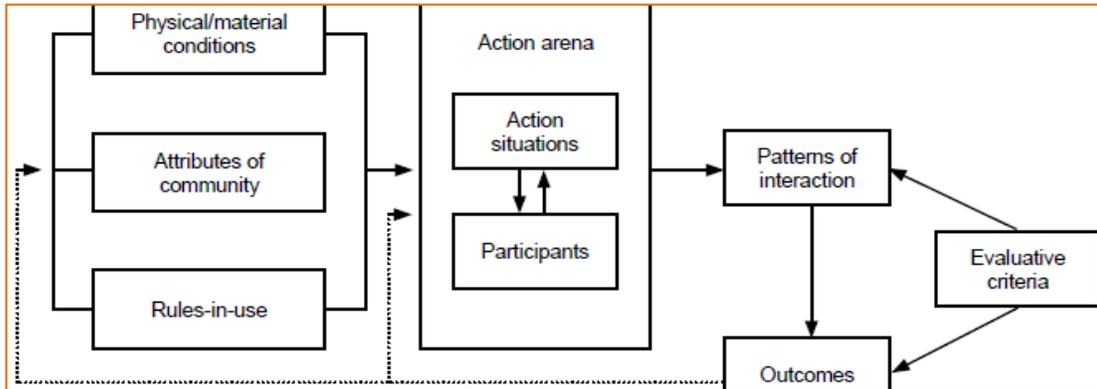


Figure 2. The Institutional Analysis and Development framework. Source: Ostrom 2005, 41.

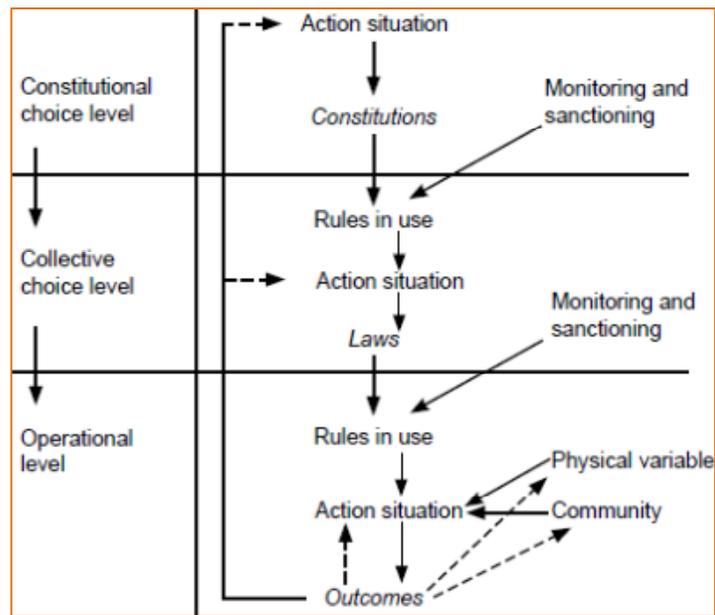


Figure 3. Levels of rules and the linkages between them. Source: adapted from Ostrom et al. 1994:47.

walk across a field

2. *Withdrawal*: the right to take something from the land, such as water, firewood, or produce

3. *Management*: the right to change the land in some way, such as to plant crops or trees, clear brush, or make improvements to the land

4. *Exclusion*: the right to prevent others from using the land

5. *Alienation*: the right to transfer land to others through rental, bequest, or sale

Access and withdrawal are considered used rights, while management, exclusion, and alienation are control or

decision making rights. Each of these bundles of rights can be further broken down and specified in terms of the products, times, and other conditions that apply to the right and whether it can be exercised alone or in conjunction with others. Each application of the IAD framework (Figures 2 and 3) focuses on a specific activity (the *action situation*), the people who take part in this activity (the *participants*) and the *patterns of interactions* between them. The combination of activity and participants is called the *action arena*. Every action arena is influenced by a number of exogenous variables, broadly categorized to be *physical/material conditions*, *attributes of the community* and *rules*. The patterns of interaction

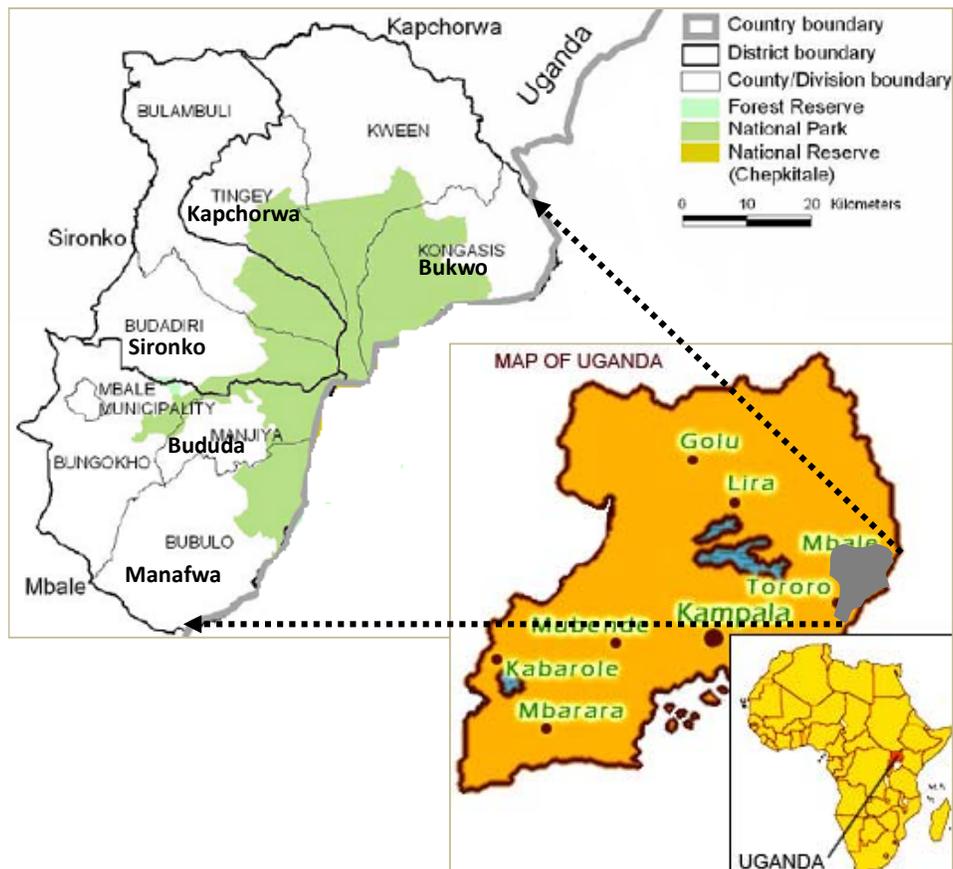


Figure 4. Mt. Elgon region. Source: Elgon map from Soini 2006 (*with improvements*).

between participants in an action arena result in *outcomes* that may feed back into the original exogenous variables and action arena and thereby restructure the situation. Rules are often nested within, or form the greater context for, sets of rules at a different level of operation. Three vertical levels of rules analysis, proposed by Kiser and Ostrom (1982, in: Schlager and Ostrom, 1992) are seen as cumulatively affecting the actions taken and outcomes obtained in any setting.

1. Operational rules. This is the set of rules that affects day-to-day decisions in action settings. Actions are taken or decisions about future actions are made by individuals operating at this level and are based on the set of institutional arrangements within which they operate.
2. Collective-choice rules. The next tier of rules typically determines what the basic operational rules are and in particular sets the rules about who is eligible to participate at the operational level. Collective-choice level decisions are made by officials in order to determine, enforce, continue or alter actions authorized within institutional arrangements. This level of rules is typically

reviewed or recreated in a 5–10 year time frame.

3. Constitutional-choice rules. This is the top tier, determining frameworks for lower-level rule creation. At this level, rules are set to guide future collective-level decisions that will authorize future operational-level actions. Therefore, constitutional choices are decisions about decision rules.

THE SETTING: MT. ELGON REGION

Mt. Elgon region is found in Eastern Uganda approximately 100 km northeast of Lake Victoria on the Kenya–Uganda border (Figure 4). The district is physically divided between lower and higher altitude regions. The former are only relative lowlands, at altitudes of about 1500 meters, with flat or rolling landscapes. The highlands, with agricultural regions at 2000 to 2500 meters and higher, include areas of steep topography and often very fertile volcanic soils (Goldman and Heldenbrand, 2002). Along the mountain slopes live the Gishu and Sabinu as the dominant tribes. The region

Table 1. Demographic and farming characteristics in Mt. Elgon region.

District	Population [2011]**	Households [2011]**	% distribution of household head by main activity ¹	
			Crop production	Livestock rearing
Mbale	428,800	96,187	79.6	0.7
Bududa	173,700	37,617	91.5	0.0
Manafwa	355,400	81,706	90.3	2.5
Sironko	233,500	52,657	87.1	1.9
Bulambuli	122,300	29,256	n.a	n.a
Kapchorwa	109,300	21,994	89.9	2.6
Kween	98,900	19,431	n.a	n.a
Bukwo	70,500	13,349	98.4	0.0

Source:¹Uganda Bureau of Statistics, 2010.** Rural Communications Development Fund (RCDF), 2011.

comprises the eight administrative districts of Mbale, Bududa, Manafa, Sironko, Bulambuli, Kapchorwa, Bukwo and Kween. Agriculture in Mt. Elgon region is principally rain fed and the quality of soils is deteriorating rapidly due to poor soil management practices (MFED, 2002). Goldman and Heldenbrand (2002) single out the recent declines in fertilizer use in most countries as well as the notable absence of fertilizer use in Uganda for the last quarter century. As a result, even substantial reservoirs of soil nutrients such as found in the more fertile areas of Uganda will be severely depleted with increasingly intensive use. Soil loss in Mt. Elgon region ranges from 45-50 t ha⁻¹ yr⁻¹ on cultivated lands (Bamutaze et al., 2011). Other results by Bamutaze (2011b) indicate that mean annual runoff rates at plot scale vary from 45 m³ ha⁻¹ yr⁻¹ to 332 m³ ha⁻¹ yr⁻¹, averaging 135 m³ ha⁻¹ yr⁻¹ at all sites.

The 2002 census statistics from the Uganda Bureau of Statistics indicate that the population density is variable in Mt. Elgon region, ranging from <50 persons per sq. km in Bukwo district in the north to over to more than 1300 persons km² in the densely populated districts in the south. This high and rapidly increasing density (with a 5.6% yearly growth since 1991) implies land scarcity in the region. As a consequence, farm sizes are small throughout the region, averaging around one hectare and even unstable slopes, often steeper than 80%, are cultivated (Knapen et al., 2005). Dependent on subsistence agriculture and natural resources – such as forests – for survival, these communities feel the negative consequences of unsupported high population growth more acutely than anyone else. In Mt. Elgon, land and resources are indeed finite, and the hereditary fragmentation of land denotes shrinking agricultural yields for individual families.

Mt. Elgon receives between 1500 and 2000 mm of rainfall each year in a relatively weak bimodal pattern. There are a variety of soil types, though most are clayey

with relatively good stability. As a consequence, most of the region is considered to be of high-potential areas and therefore major breadbasket regions for the rest of the country. Individual farms in most of the region grow a diverse set of crops, regardless of how commercially oriented the farmstead or region is. Small holding farming systems in Mt. Elgon region are undergoing a profound transformation from subsistence farming to mixed enterprise, market oriented agriculture. The transition is in some cases abrupt, but in most cases it is subtle as households more fully recognize that their household needs cannot be satisfied by farming in isolation, and they make stepwise adjustments to improve their production and marketing skills (Woomer et al., 1998 in: Sanginga and Woomer, 2009). Other characteristics of the region are presented in Table 1.

General knowledge of the availability and utilization of crop residues in the various agro-ecological zones of Uganda is important for assessing the potential of these resources. The potential of utilizing crop residues to enhance soil fertility and/or control weed growth is of particular interest in Mt. Elgon region with relatively high on-farm prices for external physical inputs (particularly chemical fertilizer and herbicides) and/or a high opportunity cost of capital/cash. In such instances, crop residues conceivably provide an economic and renewable substitute for chemical fertilizer. While crop residues have been used in Uganda in general and Mt. Elgon in particular, since time immemorial, no accurate data have been published on the quantities of crop residues produced in Uganda. In the literature, different Residue Production Ratios (RPR)/Crop Residue Ratios (CRR) values have been reported for the same crop.

Using appropriate conversion factors - crop to residue ratios/residue – production ratios given by Mineral of Natural Resources (1996) and Bingham (2004) we used available crop residue data from Bareeba and Mugerwa (1987) and conservatively estimated the quantities of

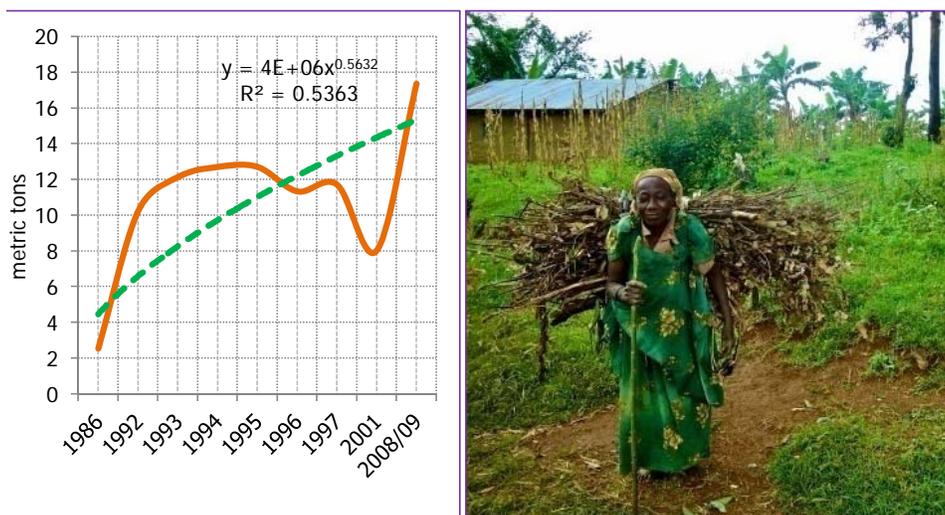


Figure 5. Estimates of crop residues (metric tons) generated in Uganda (left) and daily collections of crop residues in Mt. Elgon (right). Picture courtesy of Cavanagh, 2011.

crop residues in tons produced in Uganda and Mt. Elgon for the period 1992 to 2009. Figure 5 shows an increase in the production of crop residues in the country from 1986 to 2009 with a power relationship ($R^2 = 0.54$). Other results disaggregated by crop type are given in Tables 2 and 3 for Uganda and Mt. Elgon region respectively. However, these figures should be treated with caution since most agricultural production goes unreported and does not enter the traditional market chain in Mt. Elgon region. For reasons that are unclear, the same statistics from UBOS do not indicate production statistics for coffee; the major cash crop from the region. The uncertainties associated with the crop-residue ratios or multipliers should also be taken into account when considering these estimates. We argue in this paper that this is a reflection of the past pre-occupation with primary products and lack of interest in by-products and crop residues by the whole agricultural, rural development and research community. In the region, crop residues are used for various purposes and Figures 6 and 7 are illustrative of the multiplicity of functions that crop residues are called upon to perform.

DATA AND METHODS

An assessment was undertaken based on existing published and grey literature. We see our case and analysis as a powerful example of an in-depth study from which we can learn about the implications of crop residue framing in complex policy processes in other contexts. The methodology that was chosen enabled the elicitation of information about rules, sanctions and incentives that

are in use and their outcomes in Mt. Elgon region and allowed the analysis of institutional dynamics in the region. We analyzed our case by means of:

- a) Semi-structured interviews embedded in focus groups (FGs) in Manafwa, Bududa, Mbale, Kween, Bulambuli, Bukwo, Kapchorwa and Sironko District. The semi-structured interviews did not follow a prefixed list of questions but allowed for a conversation based on predetermined crop residue institutional frameworks. The FGs attracted a panel of district officials including district agricultural officers, extension officers, natural resource officers and women leaders;
- b) Reviews of available data and institutional frameworks and procedures and how they influence utilization of crop residues in the region by studying important moments in the decision making process. Statistical data on crop production disaggregated by districts was derived from Uganda Bureau of Statistics Annual Statistical Abstracts and this was reinforced by data from the Ministry of Energy and Mineral Development (MEMD).
- c) We also collated, scrutinized and analyzed grey literature including district council proceedings and national policy documents. These documents included the 1995 Uganda Constitution, the Local Government Act 1997, the Land Act 1998, National Soils Policy and the National Environment (Mountainous and Hilly Areas Management) Regulations, 2000, and the National Environment (Minimum Standards for Management of Soil Quality) Regulations, 2001.
- d) Two regional stakeholder workshops that sought feedback on the current implementation mechanisms of

Table 2. Estimates of crop residues generated in Uganda (1986-2009).

	1986 ¹	1992 ²	1993 ²	1994 ²	1995 ²	1996 ²	1997 ²	2001 ³	2008/09 ⁴
Plantains /bananas		419182 2	441485 6	456450 0	483944 4	491032 8	499571 1	360479 9	2307675
Finger millet	464000	110950	106750 0	106750 0	109025 0	770000	878500	695200	484636
Maize	354000	227978 7	278987 2	294950 0	316811 0	263373 0	256780 0	913002	8195981
Sorghum	312000	525001	536201	545997	558600	417200	411600	478802	526112
Rice	19000	138040	150218	156310	157154	166460	162400	108445	387198
Sweet potatoes	764000	114300 0	117480 0	127740 0	133380 0	928800	113640 0	686900	1091264
Irish potatoes	n.a	214400	256000	979199	321600	254400	288000	155726	123550
Cassava	n.a	159859 2	173272 6	114815 8	122764 8	123924 0	126463 2	667200	1597658
Beans	285000	n.a	n.a	n.a	n.a	n.a	n.a	273001	1300984
Field peas		n.a	n.a	n.a	n.a	n.a	n.a		19744
Cow peas	49000	n.a	n.a	n.a	n.a	n.a	n.a	36382	13268
Pigeon peas		n.a	n.a	n.a	n.a	n.a	n.a		15864
Groundnuts	90000	n.a	n.a	n.a	n.a	n.a	n.a	144000	606826
Soya beans	7000	n.a	n.a	n.a	n.a	n.a	n.a	55299	165270
Sim-sim	22000	n.a	515238						
Tobacco	n.a	6851	n.a						
Sunflower	n.a	22251	n.a						
Wheat	10000	n.a	n.a	n.a	n.a	n.a	n.a	10800	n.a
Coffee	140000	n.a	n.a	n.a	n.a	n.a	n.a	145172	n.a

Source: ¹Ministry of Economic Planning and Development (1988/89). In: Bareeba and Mugerwa (1987, 248); ³Ministry of Energy and Minerals (2001); ⁴Uganda Bureau of Statistics (2011).

crop residue by-laws and regulations were held. A selected group of community members was identified and invited to participate in these workshop to further clarify community arrangements on crop residue utilization in the region and also seek consensus on key crop residue utilization issues that required institutional reform.

The next section describes some of those key policies, practices and informal institutions in detail that affect crop residue utilization in Mt. Elgon region. Some derive from laws and regulations, others from customs, but all are relevant to the success or failure of interventions aimed at changing practices in crop residue utilization.

INSTITUTIONS FOR CROP RESIDUE UTILIZATION IN MT. ELGON REGION

We argue in this paper that the institutional/policy pathway affecting crop residue utilization in Mt. Elgon region is in a state of flux. Crop residue policies are implemented at different scales, ranging from local level

[household] to community [village] to district up to national levels. In this section we provide a brief overview of institutions and explore why there is increasing attention being paid to the institutional issues in water resource management.

COLONIAL POLICY AND CROP RESIDUE UTILIZATION IN MT. ELGON

As early as the 1940s, the Colonial government observed that with increasing population, land in Mt. Elgon was undergoing intensive cultivation and losing its fertility rapidly. This was a period by which policies of agrarian reform, and in particular those related to soil conservation, emerged and evolved (Carswell, 2002). The colonial government became increasingly concerned about land degradation and erosion from agriculture and livestock. The policies that evolved in response to this and the discussion of the directions that policy should follow were broadly similar across East Africa.

Four colonial approaches were adopted. First, the

Table 3. Estimates of crop residues availability (metric tons) in Mt. Elgon region in 2008/09.

		Crop to residue ratio	Bukwo	Kapchorwa	Manafwa	Mbale	Sironko	Bududa	Kween ^β	Mt Elgon Regional Total	National total
Plantains/Bananas	Leaves	0.179	709	4814	10540	17723	5269	10765	0	49820	769225
	Stems	0.179	709	4814	10540	17723	5269	10765	0	49820	769225
	Peels	0.179	709	4814	10540	17723	5269	10765	0	49820	769225
Finger millet	Stalks	1.75	60	0	884	2576	329	105	0	3953	484636
Maize	Cobs	0.27	12324	13474	5222	11514	5035	3040	0	50609	637728
	Husks	0.27	12324	13474	5222	11514	5035	3040	0	50609	637728
	Stover	2	91288	99808	38680	85288	37298	22518	0	374880	4723908
	Bran	0.93	42449	46411	17986	39659	17344	10471	0	174319	2196617
Sorghum	Stover	1.4	0	0	175	598	207	0	0	980	526112
Rice	Husks	0.27	0	0	0	288	7	0	0	295	51499
	Straw	1.76	0	0	0	1876	44	0	0	1920	335699
Sweet potatoes	Vines	0.3	215	47	950	323	255	257	0	2046	545632
	Peels	0.3	215	47	950	323	255	257	0	2046	545632
Irish potatoes	Vines	0.4	189	765	0	135	105	146	0	1341	61775
	Peels	0.4	189	765	0	135	105	146	0	1341	61775
Cassava	Stalks	0.062	6	57	234	1998	573	713	0	3580	179447
	Rhizome	0.49	44	451	1850	15789	4527	5634	0	28294	1462311
Beans	Haulms	0.7	4581	225	848	16546	1490	385	0	24075	650492
	Trash	0.7	4581	225	848	16546	1490	385	0	16445	650492
Field peas	Straws	0.6	0	0	0	0	0	0	0	0	9872
	Pods	0.6	0	0	0	0	0	0	0	0	9872
Cow peas	Straws	0.6	0	0	0	102	44	0	0	146	6634
	Pods	0.6	0	0	0	102	44	0	0	146	6634
Pigeon peas	Straws	0.7	0	0	0	0	0	0	0	0	7932
	Pods	0.7	0	0	0	0	0	0	0	0	7932
Groundnuts	Haulms	2	0	0	934	1388	736	46	0	3104	489376
	Husks	0.48	0	0	224	333	177	11	0	745	117450
Soya beans	Straws	3.5	0	0	7	70	109	11	0	196	82635
	Pods	3.5	0	0	7	70	109	11	0	196	82635
Sim-sim	Stalks	5.1	0	0	122	0	0	0	0	122	515238
Total	Total		170587	190191	106765	260341	91123	79470	0	890847	17395368

Sources: Crop production statistics derived from the Uganda Bureau of Statistics (2010). Crop residue ratios – ^αBingh, (2004) and ^βMinistry of Natural Resources (1996). Note: Kween District data are captured in Kapchorwa district data since the district was recently carved out of Kapchorwa in 2009.

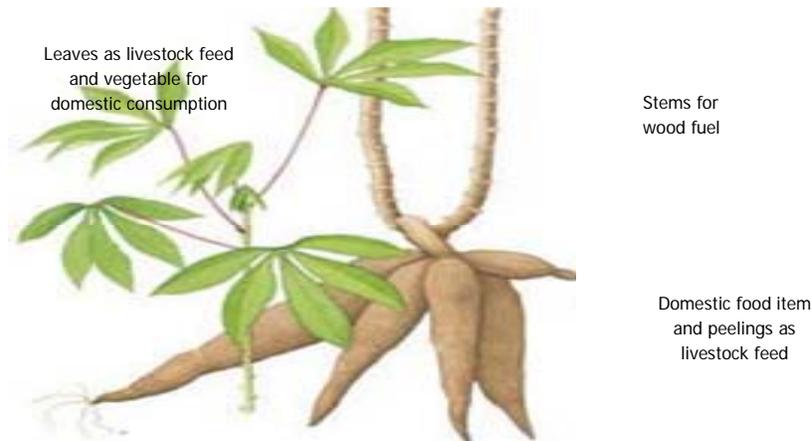


Figure 6. The importance of the cassava crop.

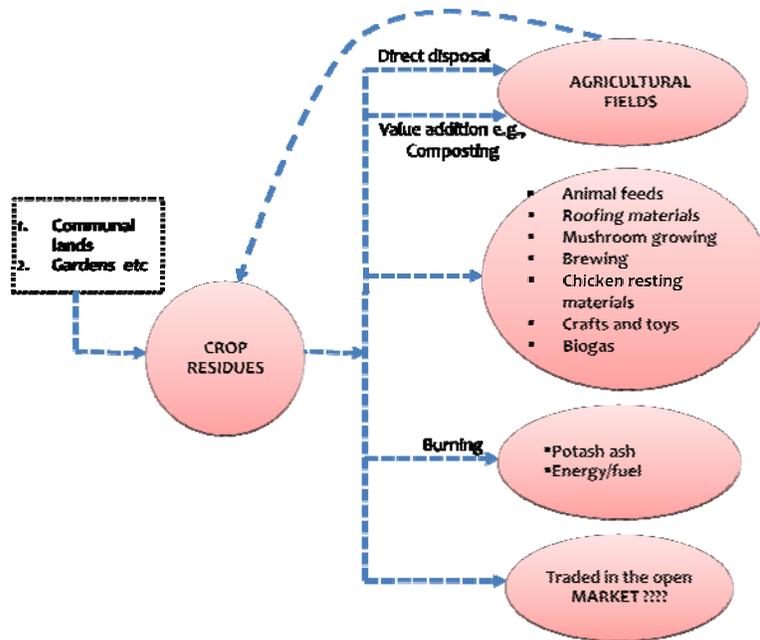


Figure 7. Flow of crop residues in Mt. Elgon region.

colonial period witnessed the development of agricultural institutions and services such as research stations, agricultural colleges, an input supply system, and processing and marketing infrastructures. Secondly, a coercive extension approach was established which in the mid-1950s, was transformed into a new methodology called 'extension through progressive farmers'. This involved targeting selected 'progressive' farmers with advice and support in the form of inputs and credit. Many of the selected farmers were relatively wealthy, had

received some formal education, and were therefore expected to adopt new technologies very quickly. The idea was that this assistance would improve the performance of the progressive farmers. Their neighbors would then follow their example and adopt the new practices, and the country's overall agricultural production and productivity would improve.

Thirdly, the state employed what Carswell (2002) refers to as the stick and carrot in introducing conservation policies: the 'stick' of enforcement in which chiefs and

regulation played a prominent role. Bylaws were formulated in accordance with the District Councils' Ordinance No-1 of 1955. Mt. Elgon region was divided for administrative purposes into counties (*sazas*), sub-counties (*ligombolola*), parishes (*kimiluka*: pl; *kumulukha*: sing) and sub-parishes (*mutongole*). With chiefs appointed at each level, a hierarchy of authority was established, each chief being directly accountable to his superior. All the chiefs (with the exception of the lowest rank) were salaried employees of the Administration. Agricultural rules made under the 'Native Authority Ordinance' were enforced in the lower courts and these rules alone were sufficient to ensure implementation. They were only clarified in 1954 when it was decided that all rules should be codified, consolidated into a pamphlet and issued to chiefs. There were fifteen Agricultural Rules of 1954 and those of relevance to Mt. Elgon included: grazing areas should be set aside where possible, and grass burning should only be done with the permission of a chief (Carswell, 2002).

Boyd et al. (2000) submitted that colonial legislation to promote soil and water conservation distinguished between African land and non-African land. On African land, responsibility for SWC was delegated to local authorities (a system which continues today). However, traditional leaders, chiefs and clan leaders were co-opted by the colonial government to enforce by-laws and collect taxes, which eroded the relationship between these traditional institutions and the people. All local authorities adopted a more or less standard set of by-laws, as follows:

1. potatoes were to be planted on soil ridges across the slope;
2. no annual crops were to be grown within 9ft (2.7m) of any perennial or seasonal watercourse or any
3. maintained road; all paths, cattle tracts, ditches and access roads should be protected against erosion by run-off
4. channels and soak-away stakes; and all house compounds except those in the growing area and compounds around buildings should be covered with mulch where possible.

The 'carrot' involved application of propaganda, competitions and educational courses. The success of these measures was achieved through the direct approach of agricultural department officers and the district team generally to the smallholder farmers concerned working through the medium of the local authority. Colonial authorities thus placed much responsibility on chiefs for ensuring that their 'patch' followed the required measures; if they failed to do so, they were punished accordingly. In addition, chiefs at each level (*lisaza*, *ligombolola*, *kumulukha* etc.) were responsible for

ensuring that all the chiefs at the level below them carried out the work expected of them. By working through this hierarchy, the administration was ensured, then conservation measures were carried out; and it is clear that chiefs were punished without hesitation (Carswell, 2002). Fourthly, a report by Goldman and Heldenbrand (2002) indicates that fertilizer subsidies existed in Uganda including Mt. Elgon region and attempts were also made to encourage people to practice soil conservation through education, propaganda and conservation competitions at sub-county or county level.

These islands of success had some aspects in common. First, there was strict enforcement of policies upon all peasant farmers. Failure to practice them resulted in heavy fines. At that time the agricultural extension service was efficient in advising the farmers on construction and maintenance of soil and water conservation measures. In fact, Boyd et al. (2000) argue that farmers identified strict customs and regulations and their uncompromising enforcement as the most important factor in promoting SWC. Villagers reported that the replacement of customs by by-laws in the colonial period had made little difference. The major difference was in the level of enforcement of the present system. Secondly, there was a high degree of local involvement but Tukahirwa (1988) reports that there was maintenance and enlargement of a well-informed extension service for imparting to the farming community up-to-date information on all aspects of farming. Government also engaged in the conduct of research, field experimentation, and investigation, designed to improve yields and quality of both crops and livestock, and to determine the best methods of land and pasture utilization.

After independence in 1962, most of the basic aspects of colonial policies and laws relating to natural resources and agriculture remained intact and continued to be implemented until 1966. Strict enforcement of laws governing soil management started weakening after independence and almost collapsed with successive regimes and these laws were later abandoned. Opposition to enforced conservation was part of the campaigning platform of the Independence movement, so government policies immediately after Independence did little to promote soil and water conservation. The jubilation of independence was accompanied by a fallacious idea that all of the colonial methods of rule should be discarded. Hence, even in land management, all forms of enforcement of control measures were abandoned (Tukahirwa, 1988). Boy et al. (2000) report that most colonial policies relating to SWC were regarded as oppressive and discriminatory, and so were discarded at Independence in 1962. Lack of leadership by local authorities after Independence, especially in the 1970s, led to serious setbacks in soil and water conservation. People experienced inadequate agricultural extension

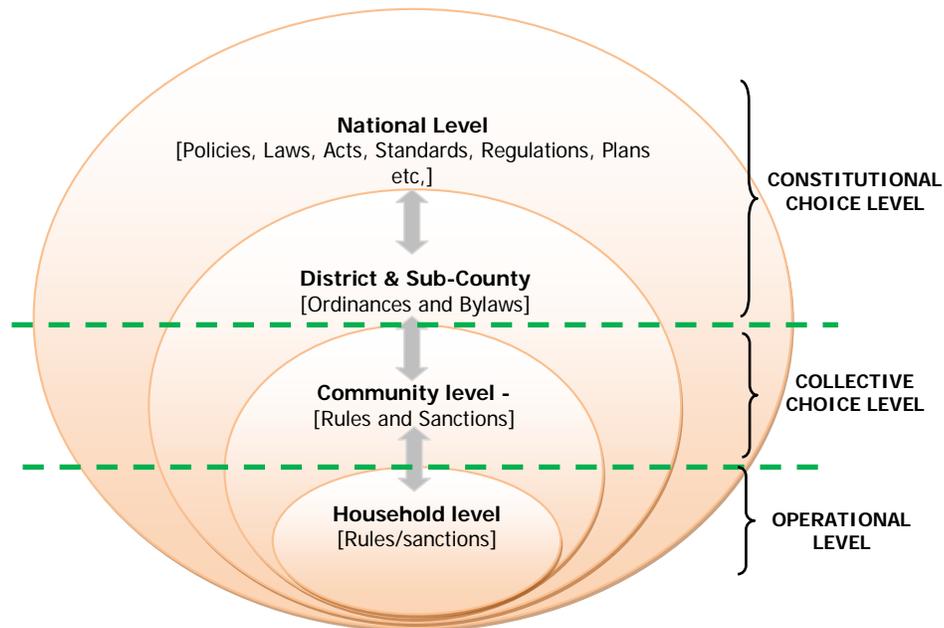


Figure 8. Key spheres and spaces in which institutions operate.

services and even as recent as the 2008/09 Census of Agriculture. UBOS (2010b) reported that the percentage of households visited by extension workers during the past 12 months was miserable 5.7, 8.7, 14.3, 31.5, 6.4 and 6.3% for Kapchorwa, Mbale, Sironko, Bududa, Bukwo and Manafwa districts respectively.

CURRENT INSTITUTIONAL FRAMEWORKS GOVERNING THE UTILIZATION OF CROP RESIDUES

We argue that modern day institutional frameworks and governance processes affecting crop residue use in Mt. Elgon region are multi-level in nature and at different spatial scales including: (a) Household level decision making; (b) Community (village) and Informal Leader Level Forums; (c) Sub County and District Level regimes in crop residue utilization; and (d) National level guidelines for crop residue utilization. These spatial scales can be illustrated in Figure 8.

Household level decision making and crop residue utilization

Unlike other regions in the world, where field crops are produced commercially and generate large concentrations of residues, much of Mt. Elgon region production and use is done by households for self-consumption.

These resources are already used as animal feed, for on-farm applications, and as construction material. Moreover, crop residues are a significant component of the solid biomass fuels used for cooking. Rights to control, use and ownership of customary land are derived from being a member of a given community and are retained by fulfilling certain obligations in the community. In Mt. Elgon region, male elders are the custodians of customary land in most communities and determine distribution of the land. However the family rather than the community has more control in the land utilization, and individuals in the family are allocated land.

Household usually possess primary use rights and there is voluntary land stewardship and a culturally accepted 'land ethic' by household members in general, and farmers in particular, that blends local agricultural production with the utilization of crop residues. Mulching is widely practiced in the banana growing districts including Mbale, Manafwa and Bududa while maize stocks in Bulambuli, Sironko, Kapchorwa and Kween districts are left in the ground after harvest and not removed to allow for the next crop to use available mineral from the decomposing matter. This method has the result that the soil is never left bare, and thus is never exposed to rain and associated sheet and splash erosion. When weeding is undertaken, the weeds and other crop residues are left in the fields to decompose and are incorporated into the soil later to enhance the nutrient cycling system and thus soil fertility. Some residues are

burnt on the fields to prevent disease transmission from one season's crop to the next. However, where the planting of a crop closely follows the harvesting of another, burning of stalks and other residues may be carried out for quick clearance.

In Uganda the guiding principle is as follows: "Any decision taken in respect of land held under customary tenure whether in respect of land held individually or communally should be in accordance with the custom, traditions and practices of the individual or group concerned; except that a decision which denies females or children access to ownership or use of land shall be null and void". Mt Elgon society is a patriarchal society in which males have the privilege of dominance over females. Existing rules and sanctions at household level reinforce and perpetuate male domination and the outcomes of these sanctions manifest themselves in form of:

1. Women being visibly active in the production and use of crop residues. Women informants confirmed that the management of crop residues creates additional demands on women's time, in terms of their collection, use and disposal. It was laborious, too tiresome and needed a lot of work.
2. Male children responsible for searching for, extracting and collecting crop residues and feeding animals especially for farmsteads practicing crop-livestock rearing.

Community level decision making and informal leader-level forums

Crop residues have for a long time been regarded as un-owned properties/assets, making them particularly vulnerable to involuntary loss to other community members. However, most of these residues are rightfully the property of rural communities and farming households, in accordance with customary norms. This conflict of claim and interest directly affects households in Mt. Elgon region. Community use of crop residues in Mt. Elgon regions recognizes the dominance of customary land tenure systems that exist in the region. Although the rules which a particular local community follows are known as customary law, they are rarely binding beyond that community. Of critical importance to crop residue utilization by customary landholders is how far national law supports their land rights. Harvesting of vegetables, bamboo, building poles, mushrooms and crop residues was done anywhere without regard of land ownership. Elders carried out conflict mediation and resolution and they passed on community rules to young generations. Resource harvest regulations did exist, for example, lighting fires outside compounds and carrying fires

through the forest and other common property resources was forbidden with ties to expectations from ancestors and observance of cultural values.

Today, the Local Council [LC] system recognized by the Local Government Act, 1997 seems to recognize the 'community development' era of the 1960s and 1970s. The LC structure provides a framework for creating village assemblies and bestows executive and judicial powers to local councilors to adjudicate in areas where tensions/conflicts arise. Local authorities do not normally interfere in land use and transfer decisions of households on cultivated land. However, when conflicts arise among community members over the use of resources on land, the local authorities generate mechanisms through which these conflicts are negotiated, mediated or regulated in time and place. Tensions frequently arise when herders send large numbers of their livestock to other farmsteads, thereby destroying and consuming a disproportionate share of crop residues. The greater the value of the residues destroyed or consumed, the greater the tension over norms and ways of working within the community. This is consistent with what Brinn, et al. (2002) observed in Northern Uganda where familial, communal and governance institutions (especially village elders, family and front-line extension workers) were of considerable importance to all farmer categories and tended to reinforce similar management practices such as observation of boundaries, time of planting, crop rotations and discouraging burning.

Indeed, the availability of crop residues for soil and water conservations is limited by their alternative uses as coking fuel, livestock feed and structural or handcraft material/fibre and the labor required to collect and process these materials. In Bulambuli district, open access regimes are dominant and for this category, various codes and legislative edicts prescribe in considerable detail usufruct rights for different users and penalties for infractions. In this regard, crop residues have been considered as common pool resources and informal sharing/access mechanisms have been developed and these are mediated by local governance systems under the direction of the LC system. In Bunambutye Sub County, rice growing in the wetland areas produces flows that are subject to two different property regimes. Rice fields that are cultivated by individual households often revert to communal use after harvest or when they are left in fallow so that crop residues and natural vegetation on these fields can be freely grazed by the entire village herd or collected by those households who need them most. Frequently this sets scenes for conflict in Sironko, where herds of cattle trespassing on rice fields or take advantage of crop residues left over in the field. In general, differing scales of exploitation, overlapping rights, and frequent contestation and negotiation of access rules characterize

the use of crop residues.

Crop Residue Learning (CRL) alliances have been established at the sub county level notably in Bukhalu (Bulambuli district) and Kaato sub county (Manafwa district). These alliances which can be judged as *forums for collaboration* bring together influential local leaders, members of women groups, environmental organizations and Makerere University and others interested in promoting the utilization of crop residues. The main activities in these learning alliances have focused on agricultural research with special attention given to on-farm experiments conducted with selected farmers, and results/ varieties shared with other community members.

Sub country and district level regimes in the crop residues utilization

By the 1980s, the pendulum began to swing the other way as academic specialists, international agencies and other specialists began to promote decentralization as a key governmental reform. These experts offered a variety of arguments for greater decentralization in environmental management noting that lower administrative units may have greater opportunities to test innovations and experiment with new policies and programs without having to justify them for the whole country. In Uganda, the central government has dissolved some powers and greater authority has been transferred to the local governments at district and sub county levels to plan and implement programs. The local governments are now charged with the responsibility of managing natural resources (e.g. controlling soil erosion, bush fire, fishing and managing of forests and wetlands). Does decentralization therefore provide new opportunities for access, allowing greater political space for local demands to be made? Are there new opportunities for access to crop residues in a decentralized framework?

District and local councils are mandated to develop specific by-laws on natural resource management, subject to approval by the National Environmental Management Authority (Boyd et al., 2000). With decentralization district authorities have mandates to influence utilization of crop residues and are required to make decisions that determine crop residue management. The district authorities are well positioned to develop policy and programmatic solutions that best meet the specific geographic, climatic, economic and cultural conditions in Mt. Elgon. They are equally well placed to develop innovative policy solutions that can be scaled up into regional or national programmes, or to provide a laboratory for national pilot programmes at the local level. In addition, the district local governments and their "bureaucrats" should provide a direct contact point for residents on questions of crop residue utilization. In this

sense, they have a greater ability to adjust policies to adapt to changing behavior and are more likely to influence popular residue utilization habits than higher levels of government.

Except for efforts geared at promoting trans-boundary natural resources management, no serious effort has been made by the eight district local governments to institute a regional crop residue framework and elevate the importance of crop residues district level. Revelations made during the focus group discussions indicated that three major activities have been tried out in Mt. Elgon region.

Manafwa District Council has drafted the '*Environment and Production Ordinance*'; with several components including: 1) the role of community members/other stakeholders in environmental management; 2) practices for river bank restoration; 3) agro forestry practices; 4) soil conservation; and 5) penalties for non-compliance in environmental management. However, the passing of the '*Environment and Production Ordinance*' at the district has been delayed by bureaucratic procedures in the district council. While sub counties and districts are required by law to formulate ordinances and by laws, there are no formal incentives to ensure anything happens and as a result nothing really happens. For most district councils in Mt. Elgon region, there is an endless planning process (from village to parish, sub-county and finally to district level) in lots of 'bottom up' plans and this has caused much disillusionment among all concerned stakeholders. It is still not clear how the institutional configuration of the '*Environment and Production Ordinance*' would result in open or closed avenues for the participation of the majority small farm holders in decision making on the utilization of crop residues. There is also ambiguity as to which department at the district should be responsible for promoting the utilization of crop residues. Major questions that arose out of the discussion with district officials included: Was crop residue utilization an environmental issue, a rural development concern, an agricultural development problem or a rural energy supply concern? Was it politically, economically and socially appealing?

In 2008, there were reports of excessive extraction and transfer of cow dung from Sironko District to neighboring areas. Sironko District local government recognized that when properly handled, cow dung manure has the potential to be a valuable commodity due to the nutrient and micro-organism content while maintaining the traditional crop-livestock interactions that have existed in the district for a long time. It instituted adhoc Manure and Cow dung Regulations; a *Code of Good Agricultural Practice for the Reduction of Export of Cow Dung*. The code has regulations concerning: 1) reductions in the excessive extraction and sale of cow dung from Sironko District to neighboring districts; and 2) guidelines

surrounding the proper handling and use of cow dung on small holder farms.

It should be noted that simply assigning authority to local users, without ascertaining the range of uses of a resource, the diversity of interests among users and the capability of existing local institutions to take on additional responsibilities, will only complicate rather than solve the problems associated with the appropriation and management of crop residues. Guidelines to local administrations on certain aspects of land use policy are available, but not strictly adhered to, as by-laws need to respond to local circumstances (Boyd et al., 2000). Decentralization has led to major coordination problems because regional and district offices of line ministries continue to be supervised by their respective ministries. Villagers associate the lack of accountability of local authorities with corruption, reinforced by the primacy of political correctness over technical performance as a criterion for promotion. Corrupt and ineffective government institutions have led to the disappearance of those soil and water conservation practices dependent on the enforcement of by-laws (Boyd et al., 2000).

National level guidelines for crop residue utilization

The last twenty years have been awash with a mix of institutional frameworks aiming at enhancing the management of the environment. The role of central government is focused on strategic planning and priority setting as well as policy making and implementation. Crop residue utilization has, however, added a new dimension to the broader and complex environmental, agricultural and rural development concerns in Uganda in general and Mt. Elgon region in particular. Complexity in environmental and agricultural/rural development derives from the variety of crop residues; the temporal and spatial variation between supply and demand; the many claimants on crop residue uses; and the combination of various consumptive and non-consumptive uses.

There exists a wide range of national policies and institutions in Uganda impact on decisions to invest, use, add value, exchange and mediate competing claims on crop residues. National environmental policies (which include elements dealing directly with erosion and conservation issues); land tenure and planning policy; and forestry, agriculture and livestock policies (including agricultural subsidies) have direct or indirect impacts on crop residue utilization at a household level.

A review of recent legislation and policy initiatives at national level revealed that there is no concerted focus to promote crop residue utilization in current household agricultural practices. Under the 1995 National Constitution, the central government is vested with most of the proprietary and legislative responsibility for the

management of resources. Although the constitution provides a number of objectives and principles that concern the environment, related legislations are very silent on crop residue utilization across the country and most specifically the Mt. Elgon region. One of the general principles in the National Environment Statute, 1995 is the involvement of the Citizens, to encourage the maximum participation by the people of Uganda in the development of policies, plans, and processes for management of the environment. The Local Government Act, 1997, the Land Act, 1998 and other acts, statutes and policies have further provisions on sectoral environmental issues and the decentralization of environmental and natural resources management but they do not clearly address crop residue utilization in the country.

With the passing of the National Environmental Act in 1994 and the subsequent establishment of the National Environment Management Authority [NEMA], the policy chronology has expanded substantially and several environmental reforms have been introduced. This, however, leaves a huge question mark hanging over the long term production and utilization of crop residues. A closer look at the National Development Agenda [2010/11 – 2014/15] which now informs development interventions in the country lacks a specific mention of crop residue utilization. However, the most relevant principles of this policy and strategy that would have important implications for crop residue utilization are: improving farming skills; improving the supply, replication and dissemination of technologies; ensuring access to land and tenure security; resolving problems of drought-prone regions; improving the agricultural marketing systems; promoting rural finance; developing the rural energy sector and rural telecom facilities.

There has been revived interest in soil and water conservation in both the Department of Agriculture and the Department for Environmental Protection. This has led to the establishment of a soil conservation unit within the Agricultural Engineering Section and a proposal to designate an officer specifically charged with soil conservation in each district. Local administrations are supposed to recruit people to work as field assistants on soil and water conservation, trained by the Department of Agriculture and paid by the local administration. Extension on SWC is carried out within the same framework as the agricultural sector as a whole. The extension system has recently been restructured and it is hoped that SWC activities will form a major component of the new structure (Boyd et al., 2000, 12). The utilization of crop residues should take advantage of this but little has been achieved in Mt. Elgon region in this regard.

In contemporary Uganda, the agricultural policies appear to revolve around the key concept of “commercialization”. For instance, in the opening pages of the Ministerial Statement of the Ministry of Agriculture,

Animal Industry and Fisheries of 2004, it is explicitly stated that the mission of the ministry is to “transform subsistence agriculture to commercial production of crops, fisheries and livestock by ensuring that the agricultural sector institutions provide efficient and effective demand-driven services to the farming community”. The strategy to deliver on this mission is the Plan for the Modernization of Agriculture (PMA) with its twin programme, the National Agricultural Advisory Services (NAADS). The Plan for Modernization of Agriculture (PMA), enacted in 2001, is part of a broader strategy of poverty eradication contained within the PEAP. In addition to addressing the falling per capita availability of food the modernization of agriculture in Uganda will contribute to the welfare of the poor by, amongst others, increasing incomes of the poor by raising farm productivity, increasing marketable agricultural production and creating on- and off-farm employment. The PMA is not conceived as a traditional agriculture sector investment programme; rather the PMA is an outcome oriented, multi-sector framework anchored to the government’s decentralized structures. In recognition that Uganda’s resources are being utilized wastefully, the key strategies under the PMA for environmental conservation are (PMA, 2000);

1. Prepare participatory land use plans at national, district, sub county, parish and village level
2. Preparation of district, sub county, parish and village level environmental plans
3. Promotion and adoption of best bet practices for natural resource conservation
4. Linking agricultural advisory services, production and environmental committees at all local government levels
5. On-farm research and demonstration of technologies for adaptation and out/up scaling purposes
6. Local administration to assist in development of viable water management technologies
7. Private sector and local government capacity building to facilitate their capacity to effectively take over the planning, designing, and management of water for production facilities

The draft national soil policy of Uganda encourages participation by all stakeholders in effort to control soil degradation. The policy also provides a framework for action to prevent and/or reduce degradation of soils and related resources and promote sustainable soil management. The policy places high priority on the need for updating soil surveys, mapping and implementation of national land use planning (Boyd et al., 2000). The importance of an educated and trained farming sector is recognized in the National Agricultural Education Strategy (Government of Uganda, 2003). This strategy was presented to cabinet for approval in June 2004 as

the National Agricultural Education Policy and Strategy (NAEPS). During 2005, the Ministry of Education had planned to incorporate the NAES into the Education Sector Strategic Plan, but this had not yet occurred as of mid-2005 (ASPS II 2005). Priority areas under agricultural education include:

1. Development of an education policy and delivery of agricultural education in primary and secondary schools, as well as tertiary institutions and universities.
2. Delivery of agricultural education to farmers, youths, extension workers, trainers and teachers through the Agricultural Development Centres and local groups. Such education is expected to be participatory, and will be implemented via role models such as farmers, teachers and extension agents within each community. Other potential activities include farmer forums, seminars, workshops, competitions, exhibitions, exchange visits or study tours and twinning arrangements between local and overseas institutions. The mass media will also be utilized.

The National Environment (Mountainous and Hilly Areas Management) Regulations (2000) applies for Mt. Elgon because of the nature of the landscape. More specifically, the regulations recognize broad principles for observing the carrying capacity of land and advising every land owner to carry out soil conservation measures. The regulations also recommend that a district environment committee may with respect to hilly and mountain areas restrict and control activities which are inconsistent with good land husbandry practices and make guidelines for the management of areas prone to a number of environmental challenges. The regulations further recommend sub-committees on soil conservation that should advise the district authorities on practical ways of conserving soils in hilly and mountain areas. The regulations also present rules for soil conservation but the closest crop residues are mentioned in Section 16, Subsection 1, Clause (f) thus:

A land owner or occupier of gentle slopes in a hilly or mountainous area shall lay parallel to and halfway between the existing bunds, trash lines consisting of dead vegetation where the land is planted with permanent crops.

The review of institutional frameworks in Uganda shows a comprehensive list of national policies and law but their impact on crop residue utilization is not clear. What has been observed through the review of national policies is that they put much emphasis on the broader issue of environmental management and more specifically soil and water conservation. For most of them, less attention is given to crop residues, for example, the Plan for

Modernization of Agriculture enacted in 2001 sought to improve agricultural input market access through various strategies, including:

- 1) improving the availability and timely distribution of high yielding, quick maturing, pest- and disease-resistant planting and stocking materials;
- 2) encouraging the participation of the private sector in seed multiplication, processing and marketing;
- 3) promoting the use of fertilizers by farmers; and
- 4) developing an effective network of stockists to make vital inputs available and accessible to the farming community (Government of Uganda, 2000). All the aforementioned national sectoral policies were approved in a period of about 20 years but they have not yet had a significant influence on soil and water conservation activities in general and utilization of crop residues in particular at the local level. Most of the policies are on paper only and are not practiced. The problems behind the non-implementation of these policies are many, but the most important is the erroneous approach to policy implementation and organization of planning in the country.

In general, there are deficiencies in national laws/legislation and current national legislation is not specifically targeted at crop residue utilization and associated activities in Mt. Elgon region but we argue in this paper that they should be seen as particularly relevant for crop residue utilization in several respects. For example, they become the foundation for local governments to realign incentives and penalties for crop residue utilization at local level.

OPTIONS TO IMPROVE UTILIZATION OF CROP RESIDUES

Utilization of crop residues is not a simple single component technology that can be easily transferred. Instead, it is a complex basket of interrelated practices that typically requires several adaptations to the entire crop production-livestock system. It typically implies a transition phase before becoming fully socio-economically viable - in terms of farmer learning, investments, local adaptation and fine-tuning and institutional change.

- a. There is a need to characterize the types of crop residues, in terms of protein content, energy content, fiber content and then recommend appropriate uses accordingly.
- b. Crop residue availability and feed availability - Areas of surplus and areas of deficit. There is a need to reconcile crop residue production and alternative utilization rates

outside the agricultural sector. Unless production practices and removal rates are carefully managed, large-scale stover removal could threaten the long-term health and productivity of the Mt. Elgon region's agricultural soils.

c. Regulations and other byelaws/local agricultural rules that penalize improper land management/crop residue burning/theft etc

d. There is a need to introduce training programmes for farmers and farming household on utilization of crop residues. These training programs should take advantage of the farmers' groups/crop residues' coalitions that have, for example, developed in Manafwa and Bulambuli district.

These training programmes should emphasize:

1. School curriculum/ household members on the importance and proper use of crop residues
2. Composting and value addition
3. Farmers competitions on best use of crop residues – use self-help groups
4. Local sharing and access mechanisms --- exchanging them on the market/pricing/ trading them on the market
5. The development and dissemination of mulching for smallholders therefore calls for some innovative approaches. Innovative agricultural extension services are important - Reliance on traditional agricultural extension procedures and structures embedded in the National Agricultural Advisory Services Programme and subsequent farmer to farmer diffusion is important in the dissemination and uptake of crop residues in agricultural production. This calls for the allocation of adequate resources (funds and manpower) and, even more importantly, the strategy that can place much more emphasis on on-farm research and development.

e. The role of academics, scientists and researchers connected to lower ranking bureaucrats is important in this particular endeavor. High level of lobbying by academic institutions and funding agencies is important in elevating the importance of crop residues in agricultural production. More research needs to be carried to determine actual use, removals and returns in small farming systems. Selective harvesting of crop residue plant parts (e.g. upper leaf and stalk portions of cereal stover) could provide a relatively high quality feed while allowing parts of poorer feeding value (e.g. lower stover portions) to be returned for soil management. The economics of such practices in terms of labor, and animal and soil responses to selective crop residue harvesting needs to be assessed before they become viable management strategies.

f. Technologies for storage of crop residues -Since the availability of crop residues is seasonal, these must be

collected and stored for use in the lean periods. Drying of straw in the field may therefore have to be carried out before storage. Of the physical treatments, only chopping and soaking are feasible under village conditions. Chopping of banana stems or maize stover improved the voluntary intake of these roughages. Baling crop residues to reduce their bulk and hence increase the quantity that can be transported could be a way of reducing transport costs. Baling is expensive for individual smallholder farmers, because of the equipment required and the need to bale large quantities to achieve economies of scale. Baling could, however, be carried out on a cooperative basis and this should take of the cooperative movement that is still resilient in the Mt. Elgon region. Reports from UBOS (2010b) indicate that about half of households in Mt. Elgon region are members of a farmers group.

g. A factor that may affect the cost competitiveness of crop residues is their high production costs such as harvesting, processing and transportation costs. At present crop residues cannot be produced efficiently due to the lack of market development and development in production technologies and infrastructures. In addition, crop residues are not densely concentrated in a particular region or area. This means greater distances have to be covered to collect and transport residues and this would increase the cost of residue production tremendously for smaller farm holders. It may be a long way to achieve such institutional frameworks as audits, standards [processes and practices] and certification of crop residues but as crop residues enter the market value chain, it is important that all stakeholders involved start to think about these in the near term.

Conclusion

Utilization of crop residues offers great agro-ecological potential: it typically conserves the soil, improves the soil ecology, stabilizes and enhances crop yield and provides various environmental services. However, whether it is actually a viable component for smallholder conservation farming in developing countries depends on a number of factors, including bio-physical, technological, farm level and institutional factors. The prevalent institutional setting is inadequate and may imply the need for institutional change (e.g. development of markets; definition and enforcement of rights/bylaws). Institutional change is more likely to succeed when it is enforced locally and thereby requires active local leadership and/or community involvement and a long-term perspective.

Conflict of Interests

The authors have not declared any conflict of interest.

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