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- Production, benefits and problems

Pernilla Olsson

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Handledare:
Supervisor: Kjell Holtenius, Swedish University of Agricultural Sciences, Department of Animal Nutrition and Management
Bitr. handledare:
Assistant supervisor: Jorge Sueze, Vi-Life, Vi Agroforestry Programme Kigali
Examinator:
Examiner: Ewa Wredle, Swedish University of Agricultural Sciences, Department of Animal Nutrition and Management
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Abstract

Intercropping involving trees is called agroforestry and makes it possible to get higher production for every area unit. The trees can function as food, fodder, fuel, medicine; prevent mark erosion and much more. Agroforestry can also be combined with animal husbandry.

The aim of this study was to document the animal production systems used by rural small-scale farmers maintaining ruminants and using agroforestry in the northern province of Rwanda. The farmers using agroforestry is expected to have higher milk yield than average due to homegrown protein.

The method used during the study was semi-structural interviews with booth open and closed questions. In order to get in contact with farmers that matched the criteria; small-scaled rural farmers with ruminants and using agroforestry, the "Vi Agroforestry Programme" (Vi-Life) in Kigali were contacted and the staff worked as supervisors, translators and contact with the farmers throughout the study.

During the study nine individual farmers, two cooperatives breeding sheep and one group interview were conducted. In total twelve interviews were made with 32 farmers. Of these farmers 28 reported that they had ruminants. The majority of the farmers had cows with milk production being the primary purpose, while the main purpose with small ruminants was compost to use as fertilizer at the fields. The biggest benefits as a result of the milk production and the compost were a daily income and higher crop yield respectively. The majority of the individually interviewed farmers housing cows had a larger milk yield than the East Africa community average of seven liters per day and cow.

Sammanfattning

Agroforestry är en verksamhet där man samodlar träd och grödor på samma mark, antingen under samma tidpunkt eller efterföljande varandra. På detta sätt blir varje ytenhet av marken mer produktiv. Träden kan fungera som foder, bränsle, medicin, markbearbetning med mera. Man kan även använda samma yta till djurhållning t.ex. med betande djur.

Syftet med denna studie var att undersöka hur produktionen i samband med idisslare och agroforestry ser ut hos bönder på landsbygden i norra Rwanda. Mjölkavkastningen hos bönder som använder sig av agroforestry antas vara högre än hos genomsnittet av bönder i Rwanda på grund av tillgången på billigt protein.

Metoden som användes under studien var löst strukturerade intervjuer med både öppna och stängda frågor. För att få kontakt med bönder som uppfyllde kriterierna; småskaligt lantbruk på landsbygden innefattande idisslare och agroforestry, kontaktades Vi Skogen (Vi-Life) i Kigali och personalen där kom att agera som handledare, översättare och kontakt med bönderna under hela studien.

Under studien utfördes nio intervjuer med bönder, två intervjuer med kooperativ med fåruppfödning och en gruppintervju; tolv intervjuer och 32 bönder totalt. Av dessa bönder sa 28 att de hade idisslare. Majoriteten av bönderna hade kor för att få mjölk, medan skälet för att ha små idisslarna var att få gödsel till åkrarna. De största fördelarna som mjölkproduktionen och gödslet genererade var en daglig inkomst och högre avkastning på fälten. Majoriteten av bönderna som hade kor för mjölkproduktion hade en större mjölkavkastning än genomsnittet för Östafrika som är sju liter per dag och ko.

Introduction

Rwanda is located in central Africa and a part of the East African community surrounding Lake Victoria. Rwanda is 26 000 km² and boarders to Uganda, Tanzania, The democratic republic of Kongo and Burundi. In 2009 Rwanda had 10.9 million inhabitants and approximately 90% of the population lived on agriculture, producing just enough to provide for the family (IPAR, 2009). Only 65 % of the habitants in Rwanda could read and the expected life span was 45 years, one of the lowest in the region (Nilsson, 2008). Approximately 57% of the population lived below the national poverty line and about 37% lived in extreme poverty; this made Rwanda one of the poorest nations in the world. More than 20% of the households were female-headed, and a majority was widows and poor. In total 43% of the households were headed by women, widows or children and represented a great part of the exposed households concentrated in the rural area (CNSL, 2010).

The average household in Rwanda consisted of 7 people, counting the number of persons that prepared meals together. In Rwanda the herds were often owned in conjunction with other family members, most often spouse or son. In many of the other East African countries the herd most commonly was owned solely by the head of the household. The access to veterinary services was said to be 100 % and Rwanda was the only East African land where Artificial Insemination (A.I) was seen as an optional source of regeneration (Wurzinger, *et al.*, 2006).

Cows could be a source of daily income for the household and be an important tool against poverty. However small ruminants require less fodder and space than cows and represent a lower risk than owning a cow (Pye-Smith, 2010). The dairy industry in Rwanda was young and expanded rapidly, 48 % of the milk was produced in the Eastern province in traditional or extensive grazing system. The farmers in that area often had more than 100 cows but the average was about 20 cows per household in the whole of Rwanda. However in the rural areas the average was more likely about 1.7 cows (Pinsoru, 2012 personal message; Kwiringarimana, 2012 personal message).

With a population density of 395 inhabitants /km², the land scarcity is acute and several enterprises competes about the space (MINAGRI, 2012). The use of intercropping crops and tree, so called agroforestry, is used in several different parts of the world in different ways (Nair, 1991). The system could help farmers to provide quality fodder to the livestock on the farm and possibly substitute the use of concentrate. This is true for the protein-rich trees that were used in Rwanda, with *Calliandra Calothyrsus* (Calliandra) being one of the major species. High quality fodder is particularly important when using improved breeds that demanded high in-put to give high out-put in the form of higher milk yield than indigenous breeds (Pye-Smith, 2010). The farmers using agroforestry was expected to have higher milk yield than average due to homegrown protein.

This study was conducted with the help of the Swedish non-governmental organization (NGO) Vi Agroforestry Programme (Vi-Life) in Kigali. For 25 years the program has worked against poverty and helped over one million small-scale farmers in the region around Lake Victoria. Vi Agroforestry educates farmers in agroforestry as well as in rehabilitation of land that threaten by erosion. Vi-Life became established in Rwanda 2004 and has its main office in the capital, Kigali (Nilsson, 2008).

The aim of this study was to document the animal production system used by rural small-scale farmers maintaining ruminants and using agroforestry in the northern province of Rwanda. Furthermore the study discussed some of the benefits and problems that the production may have and document which fodder that were used.

Literature review

Milk production

The average farm in East Africa is situated about 1200 meters above the sea level; it has between 0.5-1 hectares of land and approximately 1.7 cows. Even though the demand for milk had rapidly grown in this area, the productivity has not; the average cow gave between 7-8 liters of milk per day (Pye-Smith, 2010). Drought and lack of fodder during the dry-season, that can last 7-8 month, is the biggest problem and limits the animal production. Milk production could drop as much as 60 % during the dry season (Kwesiga *et al.,* 2003). The cows' do not produce as much milk as desired and one problem has been that the farmers had difficulties to judge the condition of the animals, especially during rainy season when good shelters were acquired (Pinsoru, 2012 personal message).

In general the decisions regarding the animals are made by the head of the household while the milk processing was done by the women in the household. Interviews with farmers in East Africa conducted by Wurzinger *et.al.* (2006) stated that in very few households the children had any responsibilities regarding animal husbandry.

In 2006 71 % of the Rwandan households had their own livestock, 16 % being in intensive systems. The milk production has increased from 58 000 tons to 257 000 tons in eight years (2000-2008) and Rwanda produced 25 % of the fresh cow milk in the East Africa community, the Eastern Province being the main milk producers. About 75 % of the produced milk were consumed in the rural areas, 91 % of this milk were sold on markets through informal channels owing to for example poor infrastructure; farmers are dependent on bicycle transporters who often bought the milk on credit or to a very low price. The lack of a working cold-chain infrastructure is responsible for the loss of 38 % of the milk because of spoilage. As a result the processors that already were installed to cool the milk only uses 20 % of their capacity (IPAR, 2009). The small-scale farmers often sell milk on local markets or have their own production of dairy products like yoghurt or cheese, while big companies buy milk from the big farmers in the east province (Kwiringarimana, 2012 personal message).

Ankole cattle are common in Rwanda and were recorded to give between 4-5 liters per day. To improve the milk production the government has promoted the use of exotic breeds in zero grazing systems as the most appropriate way to improve production. Part of this promotion was the subsidizing of artificial insemination (A.I.) as a way of replacing the local bulls with exotic breeds (Lukuyu *et al.,* 2009). In Rwanda bulls has been known to be kept in the same herd for up to as long as to the age of nine. Eight years being the average age at disposal. The average age of cows at disposal were eleven years, first mating at 30 months and calving interval about 16 months. This meant that the risk of fathers mating with daughters has been very high and subsequently the risk of inbreeding has been high as well (Wurzinger *et al.,* 2006). Because A.I. was not so well developed there were some problems e.g. lack technicians and semen. The benefits with A.I. was that besides lowering the risk of inbreeding, it was a cheaper way to get one calve of improved breed than buying a new cow of improved breed. It was also easier for the farmer to keep a crossbreed at first to learn how to care for an improved breed that was more demanding (Pinsoru, 2012 personal message). The breeds Holstein, Friesian, Ayrshire, Guernsey and Jersey are used and preferred by the East African farmers. Most smallholders prefer crossbreeds that give more milk but are not as perceptive to tropical diseases. Both health and diet have a big impact on milk production, to get the best out of the crossbreeds they need to feed with a balanced diet. This meant that the farmer needed to buy concentrate or grow his own protein (Pye-Smith, 2010). In Rwanda the most common cross were Ankole-Friesian, but there were also Sahiwal crosses, and beside disease resistance, lower feed requirements and heat tolerance were also seen as beneficial

traits. Crossbreeds are getting more common in all areas of East Africa where there are land scarcity (Wurzinger *et al.,* 2006). Partly because of the low turn back in local breeds it is not common to feed the animals with concentrate, another reason is the high cost of concentrate (200-250 RWF/ Kg) (Kwiringarimana, 2012 personal message).

One other example of attempt to not only provide the households in the rural areas with cattle but also to spread the use of exotic breeds is the program "One cow for one family". One household gets a cow of an improved breed from the government and had to give the first calve to his neighbor that in turn had to give the first calve to a new neighbor, in 3-4 years the whole village had one cow per family. This program was very important because the money from the milk could not cover the investment of buying a cow and furthermore the farmers did not know how to keep books of income and expenses (Pinsoru, 2012 personal message).

The milk produced are used both for home consumption and sold to provide an income to the household. In Rwanda and Burundi the farmers typically used mixed crop-livestock farming. The crop production and off-farm activities have a significant function in the livelihoods of the farmers in these countries (Wurzinger *et al.,* 2006). An important advantage of dairy production is that it gives a daily income to the household. When farmers from Kenya ranked the benefits from dairy production, milk for household consumption and income from selling milk were ranked highest, followed by manure production and income from selling livestock and meat. In Rwanda intensive dairy production was not as common as in Kenya and the highest ranked benefit were often manure (Place *et al.,* 2009). Another study showed that insurance value of owning livestock was very important in East Africa, Rwanda were an exception and ranked the importance of the latter as very low compared with other East African countries (Wurzinger *et al.,* 2006).

The manure was composted and put on the fields as fertilizer or sometimes being utilized for biogas production for the household before the rest products were put on the fields (Kitalyi *et al.,* 2005). The soil in Rwanda was considered very acidic and the manure could improve the soil structure, provide nutrition and reduce soil acidity, hence the importance of manure in Rwanda. It has also been shown that the quality of the fodder grown on acid soil was reduced (Pye-Smith, 2010). Only 12 % of the households used chemical fertilizer and only 7 % used organic fertilizer in 2006. One reason for the low usage was the high cost of inorganic fertilizers. The cost was about 50 % and 37 % higher in Rwanda than in the neighboring countries Kenya and Uganda respectively because of the lack of native production and hence unavoidably imports (IPAR, 2009).

Small ruminants

Africa contributes with 25 % of the sheep and 30% of the goat populations in the world. The sheep population in Rwanda was 799 000 individuals and the goat populations consisted of 2 971 000 individuals. The livestock population is growing in Rwanda and during 2005-2010 the sheep population has grown with almost 16 % and the goat population with 80 %. The total milk production in the country has grown with 182 %, cow milk included, mainly because of the program "one cow per family" (MINAGRI, 2012.). However goats are used for meat, sheep for wool and manure primarily (Pinsoru, 2012 personal message).

Goats are natural browsers thus fodder trees serve well as fodder probably even more for them than for cows. Sheep also eat shrubs voluntarily if given the choice, but do not respond with the same increase in growth rate and milk production as goats do. Nevertheless gathering shrubs and fodder from trees to small ruminants is a usual way of feeding small ruminants all over the tropics (Place *et al.,* 2009).

Most of the sheep is situated in the Northern Province while most goats are found in the Eastern province. The reason why sheep is predominant in the Northern Province and not elsewhere in Rwanda was because of cultural taboo concerning sheep production. There is a similar taboo concerning goats regarding the consumption of goat milk even though goat cheese is appreciated. Other problems on the subject of goat milk are to small and few herds and lack of support, nevertheless the knowledge do exist in the country, the evidence being the goat cheese makers (MINAGRI, 2012.).

Although the production system in general is extensive the breed used is both local and exotic, mostly crossbreeds; the local goat breed being the East African small goat. The local breed weighed generally 30 % less than the benchmark and hence was put on the marker at a greater age due to the low growth rate. The local sheep breeds gave 1.2 lambs per lambing in comparison with the benchmark 1.64 (MINAGRI, 2012.).

Free grazing and zero grazing

In Rwanda all land grazed by the animals has to be owned by the household (Wurzinger *et al.,* 2006). Free grazing in Rwanda usually mean that the livestock is fenced in; this is due to a governmental policy stating that it is illegal to let the animals graze outside the farm boundaries (Lukuyu *et al.,* 2009). The national policy of zero grazing is according to zone-coordinator in the area Kiniga in Rwanda, Kwiringarimana Teophile (2012 personal message) to prevent transmission of diseases between the livestock and to prevent land erosion through overgrazing. The same policy is the reason for free grazing to be an unusual way of keeping cows. The main fence used is live fence, constructed by hedges of poisonous, thorny or in other ways uneatable trees or shrubs e.g. *Euphorbia tirucalli.* Other fences e.g. bush pole, posts and barbed wire, are used as well. Live fences are cheaply established but could have a high maintenance cost. Unimproved natural pastures form the major part of the fodder for free grazing cattle (Lukuyu *et al.,* 2009).

More and more small-scale farmers have started to keep their livestock in a system called "zero grazing" which means that they are completely stall fed and usually housed in wooden shelters on the farm. Both cattle and small ruminants can be kept in zero grazing systems. And even though free grazing cattle demands less money and time, the high-input in the zero-grazing system also gives a high-output result and is an intensive production system, hence the total income should be higher than for free grazing systems. Zero grazing is used due to the scarcity of land and thus the competition for the resources on the farm for different enterprises. Other benefits from zero grazing or semi-zero grazing systems are the use of crop residues for fodder, on-farm production, easy collection of the manure, reduced overgrazing, easier pest and disease control, animal health management, controlled breeding and an increased opportunity for small-scale farmers to keep dairy animals. The system makes the animals completely dependent on the farmer since both water and fodder must be transported to the animal. This adds to the work load for the farmer who also has to produce and harvest the fodder (Kitalyi *et al.,* 2005).

In the rural areas teasing systems which are a kind of semi-zero-grazing systems could be seen. The animals are tied to for example a tree for as long as it takes for the animal to eat all the grass around it, then they move to a new tree and hence area. This is a very easy way to keep the animal in limited farm grazing areas that maybe couldn´t be used for any other enterprises. It is mostly used for small ruminants (Pinsoru, 2012 personal message).

Agroforestry

The management system trees and crops cultivating together it is called agroforestry. By planting forest and crops in the same area and having animals feed by fodder from, or grazing between, the trees the farmer can be self supported and hopefully get a financial backup system. The trees do not only serve as timber, food, shade and fodder, they also increase the nitrogen content in the soil by binding nitrogen from the surrounding air (Nair, 1991). Furthermore the leaves fertilize the soil and prevent the soil from drying out. Higher nitrogen content in the soil, lower degree of evaporation and fertilization with both leaves and manure generates a larger harvest which in return gives the farmer a higher income and more food. Some of the trees have fruits that serve as food; others serve as timber, feed for animals, as fabric for clothing, medical use and several other uses (Nilsson, 2008).

There are many different agroforestry systems due to both ecological and socioeconomic factors. The three fundamental types of agroforestry are agrisilviculture, silvopastoral and agrosilvopastoral. Agrisilviculture system means that trees and crops are intercropped or succeeding in rotation e.g. improved fallow. In silvopastoral stystems the components are pasture, animals and trees in many variations e.g. fodder banks. Agroslivopastoral means that all components; crops, trees, pastures and/or animals, are present in the system (Nair, 1991).

The tree that was used in agroforestry was protein-rich and provided home-grown protein in form of leaves from trees like Calliandra or *Morus Alba* (Mulberry). In Rwanda Calliandra and *Leucaena diversifolia* is the preferred fodder trees by the farmers. The ideal fodder trees have to be fast growing providing high-quality feed and should tolerate regular pruning. They can be grown in hedges, along slopes, trails or boundaries so that they do not take any space from other crops on the farm. By planting along the edges of the terraces the soil is held in place. Napier grass (called elephant grass) that is used as bulk feed for cattle could be intercropped with fodder trees. The trees could as well as provide fodder, serve as green manure (Pye-Smith, 2010). The most common fodders in Rwanda are thought to be Napier grass and the fodder trees Calliandra and *Sesbania sesban* (Sesbania) (Kwiringarimana, 2012 personal message).

In order to feed one cow with 2kg dry matter (DM) per day it is thought to be necessary to grow 500 trees. One kg of dried Calliandra is said to be equivalent to 1 kg concentrate in terms of digestible protein and both increased the milk production with around 0.75 liters (depending on farm, breed, health and quality on the fodder). The World Agroforestry Center (ICRAF) has calculated that a farmer with one cow and 500 trees that substituted dairy meal with Calliandra increased his net income with between US$101-122, if Calliandra was used as supplement to the preexisting diet (with or without dairy meal) the same figures would be US$62-11. Still the farmers found it hard to say how much of the increased milk production that depended on upgrading the livestock and how much that was due to the improved diet with fodder trees. One sign of improved health as a result of the new diet was that the cows calved once every 12 month instead of less frequently which often was the case with poorer diet (Pye-Smith, 2010).

The problem seen with Calliandra is that it is not a high-quality feed; it contains a rather high concentration of tannins which has an anti-nutritional effect especially on the digestibility of dietary protein in the rumen. However it gives excellent manure that still contains a considerable amount of protein, hence the Calliandra trees contribute to improve the quality of the manure. Calliandra also increases the butterfat content in the milk but that is not a part of the payment for the milk (Pye-Smith, 2010).

Agroforestry is a very "knowledge intensive" production. The farmers have to learn new skills which take time, effort and money (Pye-Smith, 2010). This is proved to be one reason why agroforestry is not bigger in developed countries like the USA. The cost of establishing trees and the lack of experience were singled out to be the biggest concerns for farmers thinking about using agroforestry at their farms. In Northern America five practices of agroforestry was promoted; alley cropping; wind breaks; riparian; forest farming; and silvopasture. A study has showed that only 30.9 % of the farmers reported that they had adopted at least one of the practices; the most common being windbreaks and riparian. The authors of the study concluded that a change of policy in the concerned states may stimulate the adoption of agroforestry and that the spreading of information to farmers has to be booth horizontal (farmer-to-farmer) and vertical (institution-to-farmer) (Valdivia *et al.*, 2012).

In the European Union (EU) policies regarding agroforestry are discussed with the aim to stimulate growth of these enterprises. The demand of healthier food and production systems that takes the environment in to account, as well as the national efforts to protect wildlife habitats and the ever increasing cost of fossil fuel made agroforestry a viable option for farmers all over the world. The climate change and the dependence of decreasing storages of fossil fuel also renew the interest in wood as an energy source (Valdivia *et al.*, 2012).

Vi-Life in Rwanda

Vi Agroforestry Progamme has projects in the countries surrounding the Victoria Lake, Rwanda being the newest addition with the office in Kigali opened in 2005 (Nilsson, 2008).

Vi-life works within 4 zones with 19 000 different households in the rural areas of Rwanda. About 60 % of households had cows and about 70 % had sheep or goats. In the households that owned cows it was most common to have one or two. The local breeds were the most widespread and 70 % of the farmers that worked with Vi-Life used local breeds. Naturally most of the farmers that worked with Vi-Life had fodder trees (80 %) and had less than 2 hectares when they started to work with Vi-Life, but after some years the land could have grown to 3 or 4 hectares due to increased income that made it possible to buy more land (Kwiringarimana, 2012 personal message; Pinsoru, 2012 personal message).

Vi-Life do not generally support with financially means, they instead support the farmers by education and information. Nevertheless in some cases they have given sheep to cooperatives. By giving local breed females and exotic breed male so that the offspring will be crossbred, this helps the cooperative and hence the whole community to get a source of income (Kwiringarimana, 2012 personal message; Pinsoru, 2012 personal message).

Method

The method used to conduct the study were interviews with small-scale farmers in rural areas in the northern province of Rwanda in the zone Kaniga. The interviews were carried out with help from staff from the Vi-Life program in Kigali. The staff both acted as translator as well as supervisors and contact with the farmers. The farmers were familiar with the staff which were helpful in terms of the farmers' willingness to be interviewed. The criteria for the farmers that were interviewed were that they had to be small-scale rural farmers that had production involving preferably cows, otherwise small ruminants, and used agroforestry.

In total twelve interviews have been conducted; nine interviews with farmers of whom four where women, two interviews with cooperatives that booth had a woman chairman and one group interview. The interviews have been semi-structured qualitative, using both open and closed questions; this is questions that either give opportunity to discussion (open) or can be

answered with simple yes or no (closed). This was done in an attempt to cover all areas and to get the acquired information. The main question used is attached and can be read in annex I, although the questions ware changed to fit the situation and follow-up questions unique for every interview were of course used. In total 32 farmers were interviewed.

Some farmers were interviewed at their farm while others were interviewed during different trainings that Vi-Life had for farmers. It is preferred to visit the farm due to the possibility to see how the production works in practice. The interviews took approximately 30 minutes to conduct.

The group interview could not be as detailed as the individually interviews due to lack of time; however it gave a better general view of the farmers in the area. The group interview was conducted during a break in the Vi-life training of the farmers. During the group interview 21 farmers were present. The questions asked were answered by raise of hands. The answers from the group interview have been presented with the answers from the other interviews in the result were that has been appropriated.

When interviewing cooperatives the chairman answered the questions first and afterwards all members present were able to comment. A recorder was used during most the interviews, however notes were also taken. The interviews were roughly transcribed before the result was compiled.

Results

Husbandry and production

Which ruminant species do you have and for what purpose are you keeping them?
What do you do with the calves/lambs/kids; do you sell or keep them?
Do you use zero grazing? How do you house the animals? Do you use artificial insemination?

Of the 32 interviewed farmers 21 owned one or more cows, 14 had goats or sheep and 4 farmers had no ruminants at their farm at all (figure 1). Some of the farmers hade booth small ruminants and cows which is the reason for the adding up to be more then the number of farmers interviewed (32 farmers were interviewed in total and 28 had ruminants). The use of cows was primarily milk and manure for compost or the production of biogas; also a few used the bull calves for meat. Goats were used for meat and manure and sheep for manure and in some cases wool. The offspring of all ruminants could also be sold to generate income but this was seen as a secondary use. All farmers reported that they used zero grazing and all farmers that were visited used stables build by wood located at farm (figure 2.). Of the 21 farmers that reported that they had cows, 16 (76.1 %) said that they used A.I. and 5 (23.8 %) did not.

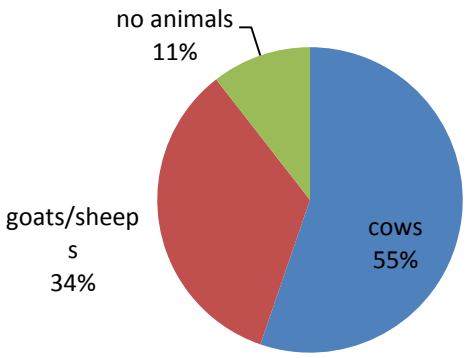

Figure 1. Different animals owned by the 32 interviewed farmers.

Figure 2. Common stables used for ruminants in zero grazing system in northern Rwanda.

How many cows/goats/sheep do you have and what breed are they?

Of the 21 farmers that reported that they had cows it was most common to have one, two or three cows and the average amount was just below 2.5 cows (Figure 3.). The eight farmers, with 25 cows in total, which were individual interviewed, were asked about what breeds they used. Most common were Frisian followed by crossbreeds (Figure 4.). The crosses were between Frisian and indigenous breeds in all cases. In booth figures all animals in the production are included regardless if they are giving milk at the present or not. This means that calves and heifers are included. The two cooperatives that were interviewed had 13 and 19 sheep respectively. The cooperative with 13 sheep had an exotic male while the females were of local breed in order to produce crossbreeds. The second cooperative had only sheep of local breed. One farmer had two goats and on sheep, the goats were of local breed and the sheep were an improved breed.

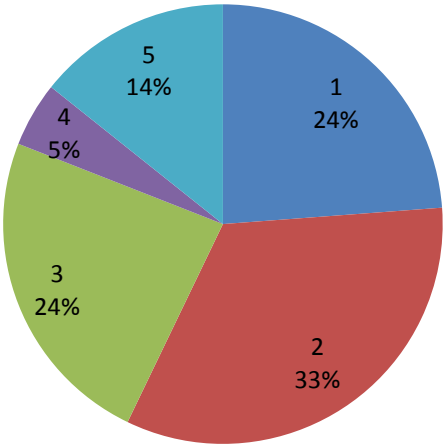

Figure 3. The number of cattle owned by every individual farmer was never more than five in the study area.

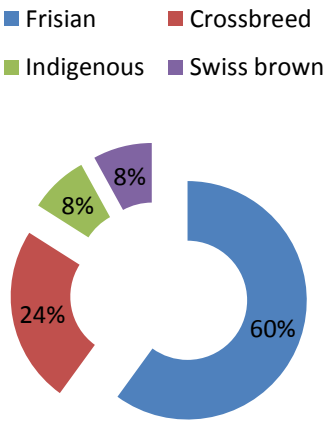

Figure 4. The most common breed used for milk was Holstein.

What kind of fodder do you use? Which tree species are used?

The farmers that had ruminants were asked what fodder they used (Figure 5.). Approximately 34 % (26 farmers of the total 28 farmers owning ruminants) answered that they used Calliandra, equally many answered that they used Napier grass and in general the used booth. In practice this meant that all farmers with ruminants besides two used Calliandra and that all

farmers with ruminants, besides the cooperatives with sheep, reported that they used Napier grass. Some farmers reported that they used small grasses or concentrate to supplement the diet. With small grasses the farmers meant all grasses that are not Napier grass and are not cropped at the farm. In the category "other", other fodder trees, minerals, residuals and shrubs are included.

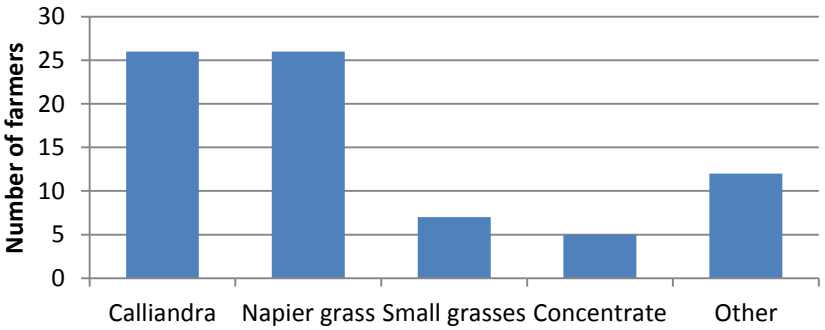

Figure 5. The fodder use by the farmers that had cows or small ruminants.

How many of the cows do you milk?
How many times per day do you milk them and how much do they yield?
Do you keep some of the milk for the household?
How often and how much do you feed the animals?

In table 1 the eleven individual interviewed farmers are summarized. The breed and yield are specified for each of the more closely interviewed farmer's milk producing cows (heifers and calves are not included). Farmer number four and two had the highest yield, 22 and 18 liters per cow and day respectively. Farmer number three got just enough milk to cover the household consumption. The mean of the milk yield for all the cows giving milk (excluding farmer no. 3 cow) were 12.6 liters per day and cow. The majority of the farmers stated that they saved some milk for household consumption. The fodders used by all eleven farmers are showed in the table. Farmer number eight had only one indigenous heifer that did not yet produce any milk. Farmers nine and ten were the two cooperatives with sheep, 13 and 19 sheep respectively. Farmer number eleven had two goats and one sheep.

Table 1.Summarizing of the eleven individual interviewed farmers

Farmer nr.	Animal	Nr. of cows	Breed	Yield (l/cow&day)	Calliandra	Napier grass	Small grass	Concentrat	Other
1	Cow	2	Cross	10	X	X	X		Salt, Tephrosia
2	Cow	1	Brown Swiss	18		X		X	Shrubs
3	Cow	1	Cross	*		X			Salt
4	Cow	3	Frisian	22	X	X		X	
5	Cow	3	Frisian	13	X	X	X		Sesbania, banana residual
6	Cow	4	Frisian	10	X	X	X	X	Leuceana
7	Cow	2	Cross	3	X	X	X		Tephrosia
8	Cow	1	Indigenous	No milk	X	X	X		
9	Sheep	13	Indigenous		X		X		
10	Sheep	19	Indigenous		X				
11	Sheep goat	1 2	Indigenous exotic		X	X	X		Salt

*Household consumption only

Benefits and problems

What effects have the cows on the household?
Do you use the manure on the field?
Have your income increased?
What problems have you had since you started?
Do you need to buy more fodder during the dry season?

The farmers reported that the biggest benefit the use of ruminants generated was higher crop yield on the field due to the use of compost. The farmers that had cows said that they saved some milk for household consumption and sold the rest. Booth milk production and higher crop yield increased the household income which made it possible to pay school fees, expand the farm by buying land and in some cases helped to get loans from banks. Some farmers also said that they were able to make money by selling fodder to other farmers.

All the farmers with cows said that the main problem was to get the cows pregnant. The farmers reported that it was hard to get a technician to come on the correct day due to too few technicians in the area. They also said it was a lack of semen in the country thus in some cases the inseminator could not offer the farmer semen from the wanted bull. The farmers also felt that because they no longer were allowed to use synchronization these problems became more difficult. Other problems were the lack of veterinarians and medicine for the animals, lack of, or too expensive concentrate and low payment for the milk. Sometimes it was hard to sell the milk and scarcity of fodder during dry season was further recognized as a problem

Despite these problems several farmers reported that they wished to expand their production in hope to continue the increase in income.

Discussion

Kwiringamana (2012 personal message) that is zone-coordinator at Vi – Life reported that about 60 % of the connected farmers had cows, this is consistent with our study showing that 55 % of the asked farmers owned cows, however only 34 % of them said that they had sheep or goats which is well below the 70 % that Kwiringamana (2012 personal message) reported to have small ruminants. This could be a result of the low number of interviewed farmers or that the staff and translators preferred to show farmers who had acquired cows. A farmer that has a cow was considered to have a better social-welfare and may therefore have been overrepresented when chosen for interview. Also some of the interviewed farmers may have had small ruminants but this may not have been mentioned during the interview due to the focus on cows.

Among farmers in the present survey the average was about 2.5 cows per household. This could be compared with average in East Africa that was 1.7 cows per household (Pye –Smith, 2010). The difference is most likely due to the result of Vi-Life's work among these farmers. The farmers were able to manage more cows when they got more knowledge about cow management and this could in turn contribute to more milk and hence money for the household. Of course other programs like "one-cow-for-one-family" and the work of other NGO´s could have similar effects, but because of this study being conducted with the help of Vi-Life and farmers connected to them, this organization can be singled out in this case. The present study was done in the rural areas. In contrast to the average amount of cows in Rwanda, about 20 cows per household due to the large-scale milk production in the eastern province, the herd sizes in these areas were relatively small (Pinsoru, 2012 personal message).

The interviews showed, just as observed by Place *et al.,* (2009) and Wurzinger *et al.,* (2006), that the use of cows was primarily for milk and manure production. Manure being very much appreciated as a product from all ruminants, and also that selling animals to generate income was seen as a secondary use. And even though sheep and goats could be used for wool and meat (Pinsoru, 2012 personal message) they were mostly used for manure among farmers in the present study. Kwesiga *et.al.,* (2003) mentioned that drought and lack of fodder was limiting for the livestock production, this was consistent with the answers in this study, several farmers reported difficulties to gather enough fodder during the dry season. The policy of zero grazing may have had a negative impact during this period of time because of its ban of use of public areas for fodder. It may be beneficial for the growth of the agriculture sector to allow farmers to gather fodder and use public areas e.g. the side of the road, so that they could sustain more ruminants even during the dry season.

All farmers stated that they used zero grazing; this was probably due to a misunderstanding. Zero grazing in Rwanda is the only legal way to keep animals according to the government policy (Lukuyu *et al.,* 2009) and therefore the farmers could not possibly have given any other answer. However in this study a difference was made between zero grazing, semi-zero grazing and free grazing; with zero grazing meaning the all-stable-feed version. This was not conveyed to the translators in a good enough way and was therefore lost in translation. It becomes obvious when traveling on the countryside that zero grazing according to the policy is conducted in several different ways; the all-stable-feed animals being only one of many systems. Maybe it would have been good to used an educated translator to prevent these kinds of misunderstandings, but because visitors was relatively rare in the area where the study were conducted it were advised that the translator should be someone that the farmers already knew to get their confidence and hence get honest answers. Nevertheless it may also be that the farmers did not feel comfortable to talk about problems or complaints with the people that

could be seen as authorities in the area and hence deserve respect because of all the help they given the farmers or strangers that they may want to impress on.

In figure 5 the use of fodder is presented and it is obvious that the majority of the farmers used Calliandra and Napier grass. Only two farmers did not use Calliandra, one used other species of fodder trees, perhaps that was more suited for the conditions on that farm. The other farmer explained that the Calliandra trees that she planted were still too small to be prune and used as fodder. In the cooperatives every member had to make sure that their sheep had fodder, that is why they could not say how many times a day they fed them. The cooperatives did not say whether they fed the sheep with Napier grass or not, but it is realistic to assume that they gave more than just Calliandra in both cases. Perhaps every member gave what they could spare that day from their own land and therefore the fodder could vary during the week. The cooperatives also reported that they could not feed the sheep with Sesbania because the sheep refuses to eat it; further investigation in that subject could be subject for another essay.

The sheep were very appreciated by the members of the cooperatives as they used the manure as fertilizer, they were not used for meat or for wool and hence the growth rate and other production traits were not very important but still they used crossbreeds at one of the cooperatives. However they wished to increase the number of sheep and may have used crossbreeding as a way of improving the fertility. Studies have shown that the local breeds only have 1.2 lambs at a time which is lower than the standard (MINAGRI, 2012). It is important to remember that these members also had their own animals in their own households that were not included in this study. In one of the cooperatives the farmers were allowed to bring every second lamb home to the household while the other lamb stayed in the cooperative´s care, this made it possible to increase the yield on the fields as well as to give every household means as they could decide what to do with the other lamb; sell, slaughter, use the wool and so on. These cooperatives could be seen as good ways of self-help in the rural areas.

In this study the most common breed were Friesian and Friesian/indigenous crossbreeds. This is consistent with the literature even though the indigenous species were not specified to Ankole (Pye –Smith, 2010; Wurzinger *et al.*, 2006). The literature also states that the crosses were more disease resistant, heat tolerant and did not need the same high quality fodder as pure breeds. However the most important reason to use crossbreeds could be the higher profitability crosses can generate due to higher milk yield. The Ankole cows were expected to give 4-5 liters of milk per day and the average in East Africa was 7-8 liters per day (Lukuyu *et al.*, 2009; Pye-Smith, 2010).

In Table 1 it is showed that the yield per cow and day in all cases but two (household consumption was assumed to be less than 5 liters) were higher than expected. In the case of the crossbreed giving just enough for the household (farmer no.3) it can be argued that it is because of a poor diet with protein content since either concentrate or fodder trees, as can be seen in table 2. In the second case of the crossbreed that gives three liters per day (farmer no.7) it is harder to see an obvious reason. It may have to do with what stage of the lactation the cow was in or the access of water as well as the quantity of fodder given. The variation that can be seen between the remaining households can be entirely because of the lactation stage, but it is interesting to see that the cows that generated the highest daily yield both got concentrate. On the other hand it is not known how much concentrate that was given per day and cow although it is likely that the farmers due to their relation to Vi-life and the support they get from them gave the recommended amount for each cow. Farmer no.6 also gave concentrate as well as protein from Calliandra but those animals still only gave 10 liters per cow and day in return. But this farmer had four cows which was more than the other farmers

had and they may all be in different ages, lactation state and may not have been fed according the their individual hence the mean may have been reduced due to poor performance of one or two individuals.

Farmer number eleven in Table 2 also had small ruminants but in contrast to the members of the cooperatives she did not have any other animals to combine them with. So even though the manure served as good fertilization on the fields she hoped to acquire a cow in the future so that she could get that daily income that the selling of milk can give. The problem is that cows are very expensive in relation to the milk price (Pinsoru, 2012 personal message) as a result the farmer has to acquire a cow from the government plan, an NGO or any other help organization otherwise the investment do not pay off. The income that the cow generates was not enough to cover the cost of obtaining and maintaining a cow in the rural areas of Rwanda. But the big farms in the east shows that it was possible to get profit with the price rate at the time but that a bigger production is necessary. Another explanation could be that the farmers were not educated enough and may not be able to keep records; they may be illiterate, unskilled in math and so on, making it impossible for the farmer to see what investment is possible to get a good turn back on (Pinsoru, 2012 personal message; Nilsson, 2008). This is a big obstacle for further development in rural areas and it was aggravated by the culture of not sharing information that can be the case in some areas. To keep books means that it is possible to see how much the economy has improved, how much land the farmer has and so on, this could be information that the farmers do not want to share in fear of losing their advantage against other farmers.

Although A.I. was subsidized by the government and 78 % of the farmers with cows used it, they were generally concerned by the low fertility. One of the biggest problems that the farmers had was the lack of technicians that could perform A.I. in their area. This often led to poor fertility and that the cows were not used sufficiently, with fewer milk giving months per year than what is possible. It also makes it impossible to use the calving interval as an indicator of health and good diet as suggested by Pye-Smith (2010). This problem is further complicated by the ban of synchronization that has been used earlier to make all cows be in heat at the same time; thus it easier for the farmers in the past because they did just need the technicians once to get all the animals inseminated at the same time. However Pinsoru (2012 personal message) claimed that a problem in his region was the difficulties farmers had to judge the condition of the animals. If the animals are too lean this could also affect the fertility, the same may be true during dry season or other times of shortage. Also it can be hard to keep the animals healthy during the rainy season due to the constant wetness which can start outburst of disease and the rain together with poor sheds can lead the animals to freeze and lose important energy. Furthermore the difficulty to judge the condition could affect the feeding plan, the farmers not being able to adjust it properly to the varying conditions.

The problems regarding A.I. could also make farmers to start to use more live bulls instead. That would make crossbreeds harder to buy and also the choice of bull may be determent solely on availability and the aesthetics of the bull, also the handling of bulls is dangerous and they could cause a lot of injuries. Furthermore the inbreeding would probably increase due to the long service of each bull in the same herd (Wurzinger *et.al,*. 2006) and because of the long use of the same bull the breeding progress would slow down.

Farmers also said they had problems to have their animals treated by a veterinarian which shows that the access is not 100 % all over the country as suggested by Wurzinger *et al.*, (2006).

Most farmers in Rwanda do not afford to buy inorganic fertilizer (IPAR, 2009) therefore manure is an important part of the agroforestry generating higher crop yield and thus higher income. The benefit of small ruminants is that the farmers get access to cheaper fertilization as well as getting some economical security due to the possibility to sell animals when in need of money for example to pay school fees, hospital bills etc. Also it was easier and cheaper to have several small ruminants than cows as well as the loss of one goat was not as devastating as the loss of the only cow (Pye-Smith, 2010). However the benefit with cows according to the farmers was the daily income of money and the possibility to feed their children every day. With a daily income of that level it was possible to buy commodities that cannot be generated at the farm; school books, candles and so on. To be able to feed the children every day, even if it was only just on glass of milk did not only increase the wellbeing of the children it also increased the psychological wellbeing of the parents and gave an indicator to the family that they are getting out of poverty.

The farmers collaborating with Vi-Life were expected to have higher milk yield than average due to the use of agroforestry system and homegrown protein. Our interviews show that this seems to be the case even though larger studies, taking more parameters into account have to be conducted to confirm these results. Nevertheless it is hard to say what this trend is based on; probably it is an effect of better knowledge among the farmers and the use of breeds with potential better performance. The use of homegrown protein which would be cheaper may increase the profitability to some extent and make it possible manage breeds with higher potential.

Valdivia *et al.*, (2012) discussed the use agroforestry in developed countries and briefly mentioned the possibilities to produce products in a more environmental friendly system. Agroforestry may be more suitable for small-scale farmers but that do not necessarily mean that it is not suitable for farmers in developed countries. Countries with a large production of wood can with the help of agroforestry make additionally profits and products. To use sheep as weed controllers in tree plantations can give added value to the land. Due to the ever increasing prices on fossil fuel it can be the other way around; countries with too little trees for firewood could use agroforestry to find an alternatively energy source.

It is important to recognize that the translators that were used were not independent and that the farmers therefore may not have been so comfortable to talk about problems and complains they may have. It is also possible that the farms that were visited may not be representative for the production in Rwanda. It may well be so that the farmers that are doing well has been prioritized by the staff, both to show how good the work can be, but also to motivate the farmers that are doing the best in the area. In an attempt to ensure that the whole picture were understood, different kind of questions both short closed ones and more open bigger questions were used. The translators that were used were not educated as such and may therefore not understood the importance of translating the whole answer and not just what they considered the most important points. Even though the number of interviews conducted in this study is too small to give any conclusive answers it shows trends that requires further investigation.

Conclusion

Agroforestry was a major part of the feeding plan used in the rural areas of northern Rwanda, mainly using Calliandra and Napiar grass. The farmers thought that the main propose of keeping ruminants were to get manure to fertilize the fields and milk from the cows to sell to get money, while insurance value and income from selling animals were not as important. Fertility due to too few technicians than can perform A.I, fodder availability during dry season, lack of medicines, expensive concentrate and to low milk price were considered to be the biggest problems.

The majority of farmers had higher milk yield than expected. It is hard to say from this study what has had the biggest impact on the milk yield. It is reasonable to assume that this is a combination of knowledge, improved breeds and access to homegrown protein in terms of fodder trees that have contributed to increase the milk production due to better management of the animals.

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References

Kitalyi, A., Mwangi. D.M., Mwebaze, S. and Wambugu, C. (2005). More forage, more milk: forage production for small-scale zero grazing systems. Technical handbook No. 33 Nairobi, Kenya: Regional Land Management unit. World agroforestry centre. 112p.

Kwesiga, F., Akinnifesi, F.K., Manfongoya, P.L., McDermott, M.H. and Agumya, A. (2003). Agroforestry research and development in southern Africa during the 1990s: Review and challengers ahead. Agroforestry systems 59, 173-186.

Lukuyu, B.A., Kitalyi, A., Franzel, S., Duncan, A. and Baltenweck, I. (2009). Constraints and options to enhancing production of high quality feeds in dairy production in Kenya, Uganda and Rwanda. ICRAF Working paper no. 95. Nairobi, Kenya: World Agroforestry Centre.

Nair, P.K.R. (1991). State-of-the-art of agroforestry systems. Forest Ecology and Management 45, 5-29.

Nilssson, P.U. (2008). Vi planterar framtiden: Vi-skogens strategi 2008-2011. Stockholm: Vi-skogen.

Place, F., Roothaert, R., Maina, L., Franzel, S., Sinja, J. and Wanjiku, J. (2009). The impact of fodder tree on milk production and income among smallholder dairy farmers in East Africa and the role of research. ICRAF Occasional Paper No. 12. Nairobi: World Agroforestry Centre.

Pye-Smith, C. (2010). Fodder for a better future: How agroforestry is helping to transform the lives of smallholder dairy farmers in East Africa. ICRAF Trees for Change no.6, Nairobi: World Agroforestry Centre.

Valdivia, C., Barbieri, C. and God, M.A. (2012). Between forestry and farming: Policy and environmental implications of the barriers to agroforestry adoption. Canadian Journal of Agricultural Economics 60, 155-175.

Wurzinger, M., Ndumu, D., Baumung, R., Drucker, A., Okeyo, A.M., Semambo, D.K., Byamungu, N. and Sölkner, J. (2006). Comparison of production systems and selection criteria of Ankole cattle by breeders in Burundi, Rwanda, Tanzania and Uganda. Tropical Animal Health Production 38, 571-581.

Commisson Nationale de Lutte Cotre le Sida (CNSL). (2010). National Accelerated Plan for Women, Girls, Gender Equality and HIV 210-2014.

Institute of Policy Analysis and Research – Rwanda (IPAR). (2009). Rwandan Agriculture Sector Situational Analysis - An IPAR sector review. IPAR Rwanda Report August 2009.

Ministry of Agricultur and Animal Resources (MINAGRI). (2012). Strategy and investment plan for small animals industry in Rwanda. INTERIM Report.

Non published references

PINSORU Oscar zone-coordinator for Gasabo district (2012-05-28)

KWIRINGARIMANA Teophile zone-coordinator for Kaniga district (2012-05-29)

Annex I

Questions asked during the interviews

Questions to farmers and the cooperative

How many cows/sheep/goats do you have?

How many of the cows do you milk?

Which breeds do you have and for what purpose are you keeping them?

What do you do with the calves; do you sell or keep them?

How many times a day do you milk them and how much do they milk?

Do you keep some of the milk for the household?

Do you use zero grazing?

What effects have the cows had on the household?

Do you use artificial insemination?

Do you use the manure on the field?

Have your income increased?

What problems have you had since you started?

What kind of fodder do you use?

Which tree spices?

How often and how much do you feed the animals?

Do you need to buy more fodder during the dry season?

Questions for group interview

How many participates?

How many has cows? More than 1, 2, 3, 4?

How many gets milk from the cows?

How many is using them for manure?

How many uses A.I.?

How many of you have problems getting the cows pregnant?

How many of you have sheeps or goats?

How many are using them for meat/milk/manure?

How many of you with livestock are using foddertrees?

How many is using Calliandra?

How many uses other trees or shrubs? Which spices?

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