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Benefits and conflicts from integration of livestock into the organic agricultural system in Sub-Saharan Africa

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1. Introduction

Modern organic agriculture is a concept, that have evolved since the 1920s, when the first pioneers of organic agriculture (Rudolf Steiner, Robert McCarrison and Sir Albert Howard), expressed their concern about the use of inorganic fertiliser in agriculture, and faced a turning point with the publication of "Silent spring" by Rachel Carson in 1962 (Kristiansen & Merfield, 2006). The International Federation of Organic Agriculture Movement (IFOAM) was founded in 1972 (IFOAM, 2010), and has formulated four key principles on which organic agriculture build upon: Health, Ecology, Fairness and Care (IFOAM, 2005). These principles should be adopted world-wide, inspire the organic movement (IFOAM, 2005) and ensure that the organic production are adapted to the local conditions of the individual farm (Kristiansen & Merfield, 2006).

Organic agriculture are very often, in the global south, confused with traditional farming, farming without chemical inputs or certified organic farming for export (Vaarst, 2010). In this assignment organic agriculture refers to agriculture based on the organic principles and is defined as followed: "*Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved*." (IFOAM, 2008). This leads to a concept of organic agriculture, in which certification not necessarily is implied.

Soil fertility and biodiversity will be enhanced, and land degradation, erosion, poisoning and other negative effects of chemical activities will be minimised, if the principles of organic is followed in practice (Vaarst, 2010). This is achieved by using agro-ecological farming methods, such as incorporation of legumes and compost to improve soil fertility, crop diversity to prevent pest and diseases and inter-cropping (Anonymous, 2010; Vaarst, 2010). The farmers can intensify and increase production, without necessarily depending on chemical pesticides and fertilisers, by using the agro-ecological farming methods (Anonymous, 2010). This leads to reduces risk of becoming indebted or poisoned by pesticides.

Agriculture are the basis for millions of peoples livelihood (Anonymous, 2010), and population pressure and low yields affects the farmers, so that they abandon the traditional farming system, with fallow and crop rotations, which has maintain their livelihood for millennia (Belay & Edwards, 2003). Livestock keeping are an important livelihood strategy for African smallholders (Descheemaeker et al., 2010). Soil fertility is general low in Africa (Lobe, 2008), and therefore, have there been approached to increase the soil fertility through chemical inputs (Belay & Edwards, 2003; Lobe, 2008). Some farmers have been fallen into the dept trap, because of the cost of purchasing chemical fertilisers (Belay & Edwards, 2003; Lobe, 2008). The organic agriculture, is an alternative to farming with chemical inputs, which can contribute to productivity increase and to reduce vulnerability and poverty among African farmers (Anonymous, 2010). With the use of organic farming practice the farmer does not have to purchase chemical inputs for the farm. The organic agricultural production system, is a system which are well-adapted to smallholders (Anonymous, 2010) and are a way of improving food security among smallholder farmers in developing countries (Halberg et al., 2009).

In developing countries lives 60% of the population in rural areas and of those is 85% agriculturalist (Dixon et al., 2001). The rural areas are also where 70% of the total poverty are found, with the poverty concentrated in South Asia and Sub-Saharan Africa (Dixon et al., 2001). Broad-based agricultural are in general a way of reducing poverty (Dixon et al., 2001), and especially livestock keeping are a way of

escaping poverty in the rural areas (Peden et al., 2007) and have been a part of the culture of some communities for millennia (Omore et al., 2009). Livestock are a way to attain the organic principles of ecology, which says that "*organic agriculture should be based on living ecological systems and cycles. Work with them, emulate them and help sustain them*" (IFOAM, 2005). It means that the organic farm should base it production on ecological processes and recycling. Livestock production should therefore form an integral part of many organic farms, because of its role in nutrient recycling on the farm (Hermansen, 2003; Powell et al., 2004). In a natural ecosystem the wild herbivores scatter their faeces and urine in the environment when they are grazing, which gives nutrient for plant growth, which provide food for the herbivores, which then produce more faeces and so on.

When livestock are integrated into the whole system, is creates a situation where the livestock contribute to the system and at the same time the system should contribute to sure that the principles of fairness to obtained. Which means that "*animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being*" (IFOAM, 2005).

The integration of livestock into the whole system can both give benefits and conflicts. Therefore is the aim of this assignment is to illustrate (explore, discuss and analyse) some of the benefits and conflicts from integration livestock, especially ruminants, into the whole farm, with a specific focus on Sub-Saharan Africa. The first section of this assignment gives some highlights of the livestock in Sub-Saharan Africa, followed by a description of benefits from integration of livestock with focus on nutrient recycling and a description of conflicts, with focus on breeds and water. A case from Ethiopia will be reviewed and the final section will be a discussion of the case in relation to integration of livestock.

2. Livestock in Sub-Saharan Africa

In the Sub-Saharan Africa region are 61% of the people involved in agriculture and under 10% of the land are cultivated, which is one quarter of the potential cultivated area (Dixon et al., 2001). In this region is there a lot of different farming systems, and most systems involves livestock (Dixon et al., 2001). The animals have different roles depending on the farming system. They can provide draft power for tillage, crop planting, weeding, crop harvest, processing and transport (Powell et al., 2004; Peden et al., 2007; Wilson, 2009; Descheemaeker et al., 2010), and the animals that provide draft power are cattle, donkeys, horses and camels (Powell et al., 2004). Beside draft power, meat and milk can be provided from the livestock for the households and for sale to generate cash income (Powell et al., 2004; Wilson, 2009). Other things from the animal, like hides and blood, can also be used (Peden et al., 2007; Wilson, 2009). The cash income from livestock product is often invested in crop production technologies (Powell et al., 2004) and can help the farmer with major or unexpected family expenses (Peden et al., 2007). Livestock keeping are often an source of wealth security and storing capital (Powell et al., 2004; Peden et al., 2007). In some areas are livestock keeping also a way of meeting social and religious obligations of the farmers (Powell et al., 2004; Descheemaeker et al., 2010). In general is livestock a form of risk spreading (Descheemaeker et al., 2010), when it is broad-based farming.

East Africa, a part of Sub-Saharan Africa, is home to at least half of all ruminant livestock (Omore et al., 2009). The number of animals has been growing in connection to the growth in the human population (Omore et al., 2009), and the density of animal are often connected to the density of humans

(Peden et al., 2007). Poor farmers have a tendency to keep smaller and cheaper animals such as poultry, small ruminants (sheep and goats) and pigs (Omore et al., 2009).

The possibility for raising cattle and other ruminants depends on local conditions. The condition for raising animals is better in the sub-humid areas (with less rain and a dry season), then in humid tropic (with heavy rainfall) (van Schöll & Nieuwenhuis, 2004). In the semi-arid and arid areas are the feed scarce and the possibility for growing the feed is not there, so in these areas it is difficult to keep animals in stables (van Schöll & Nieuwenhuis, 2004).

3. Benefits from integration of livestock

The farmer can have livestock production without crop production and reverse. This can be pastoral farming system or be a forest based farming system, in these two system are the basis for their principle livelihood respectively livestock or crops (Dixon et al., 2001). But the integration of the livestock and crop production gives the farmers benefits, and the benefits from crop-livestock integration are many (Devendra & Thomas, 2002):

Crop production provide crop residues which livestock can utilise and could be wasted in the absence of animals (Devendra & Thomas, 2002). The crop residues could also have been use in the process of compost making (van Schöll & Nieuwenhuis, 2004; Inckel et al., 2005).

Crop production in alley-cropping systems, which are an system with strips of annual crops grown between rows of trees or shrubs (Verheij, 2007), can provide tree forage for livestock (Devendra, 1997) (cited from Devendra & Thomas, 2002).

Pasture, both native and improved, and cover-crops growing under perennial tree crops can be grazed by livestock, and grazing animals under the trees can be beneficial in weed control (Devendra, 1997) (cited from Devendra & Thomas, 2002).

The draft power from the animals can improve quality and timing of farming operations, which can improve crop yields and thereby income (Devendra & Thomas, 2002).

Livestock also contribute to the maintenance or improving the soil fertility, through the transfer of nutrient (excrement and urine) from the animals to the cropland (Devendra & Thomas, 2002). The animals also provide a least cost, labour-efficient route to intensification of the production (this is because of their role in nutrient cycling) (Devendra & Thomas, 2002).

Livestock product can be sold (Powell et al., 2004; Wilson, 2009) and together with hiring out draught animals it can provide cash (Devendra, 1997) (cited from Devendra & Thomas, 2002).

The livestock can be an entry-point for introduction of new crops into the cropping system, i.e. herbaceous forage crops can be sown in intercropping system or under shrubs and trees established as hedges in a agro-forestry system (Devendra, 1997) (cited from Devendra & Thomas, 2002).

3.1 Nutrient recycling

The livestock, independent of species, produces manure (Devendra & Thomas, 2002). Manure is animal excrement and urine, which usually is mixed with straw or leaves (van Schöll & Nieuwenhuis, 2004). The feed provided to the animals in the livestock herd, affects the amount and quality of the excrement (van Schöll & Nieuwenhuis, 2004), which affect the manure.

When livestock and crop production is integrated, and the farmers want to use the excrement as manure, he/she has to somehow be able to collect the excrement from the animals. In a system there the animals can grass freely and thereby gather their own feed, the animals will scatter their excrement randomly around the grazing area (van Schöll & Nieuwenhuis, 2004). The collection of the manure in

this type of system will be labour intensive. Instead the farmer could have the animals in stables. This also affects the nutrient content of the manure, because in the freely grazing system a part of the nutrient will be leached or volatilised, and in the stables the nutrient in the manure can be protected from leaching and losses (van Schöll & Nieuwenhuis, 2004). Keeping the animals in stables, in areas where the livestock normally graze freely, will changes the labour requirements (van Schöll & Nieuwenhuis, 2004). There will be a need for labour to gathering feed and cleaning out the stable. In the sense of protecting the nutrient content in the manure, keeping the animals in stables is the best solution. Keeping of animals in stables are a way of completely ban animals from grazing land and this is, together with restricting the grazing, a way of minimizing or reverse the effects of overgrazing (Asefa et al., 2003).

A good manure consist of excrements and urine, where straw and leaves have been added and the mixture has been aged (van Schöll & Nieuwenhuis, 2004). The ageing process of the manure has a positive effect on the manure. Fresh manure from an stable has a high C:N ratio, this can cause nitrogen immobilisation (van Schöll & Nieuwenhuis, 2004). In the ageing process the C:N ratio is decreases, which has positive effects on availability of the nitrogen. Beside this, there are also other, advantages from keeping and ageing manure, which are: harmful substances that are released in the first stage of decomposition, which can inhibit plant growth or burn the leaves, are eliminated, weed seeds are decomposed or loses their germination ability, few nutrient are lost through run-off or volatilisation and aged manure is easier to transport (van Schöll & Nieuwenhuis, 2004).

Manure is an ideal fertiliser (Devendra & Thomas, 2002; van Schöll & Nieuwenhuis, 2004), but the manure is not always used as an fertiliser. In some areas with little fire wood, is dried manure used as cooking fuel (van Schöll & Nieuwenhuis, 2004). In these areas are a source of nutrient not used as a fertiliser, but there are ways to get the farmers to use the manure as a fertiliser. This can be to find an alternative fuel source; it could be through the planting of trees.

Farmer in the humid tropic often do not have enough animals, so that they can produce the manure needed for retain or improve soil fertility, but in these areas can other methods, like green manure, intensive fallow periods and agro-forestry, be used (van Schöll & Nieuwenhuis, 2004). In the semi-humid areas is the need for manure less, because there are a slower decomposing of organic material (van Schöll & Nieuwenhuis, 2004).

The manure can also be used in compost making processes. Compost is like manure a fertiliser, and to create compost the farmer need organic material like crop residues, straw, manure, kitchen wastes etc., which are collected and stored together (van Schöll & Nieuwenhuis, 2004; Inckel et al., 2005). In general is the use of manure or compost as a fertiliser is a method to retain and increase soil fertility (Devendra & Thomas, 2002; Inckel et al., 2005; Peden et al., 2007), and benefit from integration of livestock into the crop production.

4. Conflicts from integration of livestock

When livestock is integrated into whole system some conflicts can exist. As all ready mentioned, when the farmer want to use the manure, animals in stables are a way of having control over the manure. This crated a conflict between the animals individual right to have condition that provides the opportunities to perform their natural behaviour, which is the principles of fairness (IFOAM, 2005). The organic animal welfare concept can been understand as the animals right to a natural living, which include the opportunity to performing a natural behaviour, to get feed that are adjusted for the animals physiology need and living in an environment that resembles the habitat which they are evolutionary adapted to

(Lund, 2006). With this concept of animal welfare in organic production and the principle of fairness, the livestock should not be in a stable the whole day, because it deprives the animals from grazing which is a part of their natural behaviour. So it is a conflict between having control over there the animals leaves the excrements and the right to perform a natural behaviour.

4.1 Species and breed

In sub-Saharan Africa is the native livestock a multi-purpose animal (Wilson, 2009). In other places of the world is the livestock a single-purpose animal, dairy-cows for high milk production or slaughter chicken and pigs for meat production. When livestock is integrated into a system, it is supposed to give a lot of benefits, and if the farmer do not have the right animal it can created problems. So there can be a conflict between the wish for having an animal with a high yield and an animal that have several purpose/benefits.

The development partway in the twentieth century was upgrading or replacing the indigenous breeds in the tropics with exotics breeds (Gura, 2008; Wilson, 2009). An exotic breed is in this case a breed that come from the temperate climate, and the indigenous breed are a local adapted breed. The native or indigenous breeds have some characters, which the exotic/temperate breeds to lesser degree have, and those are (Wilson, 2009):

- A lower metabolic rate that generates less heat
- Reduced panting but more ready sweating that conserves energy
- A feed intake less affected by high temperatures
- A higher intake of poor quality feed
- Higher digestibility and efficiency of feed conversion
- Lower water requirement
- A greater ability to retain feed and water in the large intestine
- Better resistance to ticks, insects and some diseases

The exotic breeds are finely tuned, genetically engineered and highly productive animals that need large quantities of high quality inputs and management, but in the environment in Sub-Saharan Africa and in the tropic in general, they are not the best fitted animal (Wilson, 2009). It is also important to remember that the indigenous breeds have a multi-purpose and it can provide the farmers with a lot of products (mention earlier) on resources, where a specialized (single-purpose) breed would not be able to perform and provide the same products (Wilson, 2009). For the farmer it is positive that the native animals have the capacity to utilize low quality feed into proteins (Wilson, 2009). When the exotics breeds are imported to the tropic, they will do well while the development project is ongoing, but after the end of the project the exotics breeds disappear again, and the reason for this failure to establish exotic livestock include (Wilson, 2009):

- High import costs
- Heavy mortality
- Poor fertility
- Reduced appetite due to high temperature and humidity
- Low quality pasture
- Susceptibility to internal and external parasites
- Inadequate management skills

Even though that the general situation is that the introduction of exotic breeds do not lead to a permanent change in breeds, is there cases of successful introduction of exotic breeds, but it has been in special conditions (Wilson, 2009). A successful introduction is the introduction of European dairy breeds to tropical highland parts of Kenya, South America and subtropical areal like Zimbabwe, in these places are the climate and other environmental conditions less severe (Wilson, 2009)

The right animals is not necessary the animals that produce most, especially in the tropic areas. This leads to the concept of the right animal in the right place, which is the concept of having animals that are suited for the particular place. The right animal spices or breed has to have the following qualities (Wilson, 2009):

- Adaptation to local physical, nutritional and management environments
- Acceptability to local people
- Resistance to common diseases of the area
- Good reproductive and growth performance
- Adequate yields of meat, milk, draught power and other products in relation to the prevailing management system, feed availability and veterinary services

4.2 Water:

Livestock requires, in general in the developing countries, large amount of water, both as drinking water and water for feed production (Peden et al., 2007). The livestock production depends on access to sufficient supplies of feed, this can be grains, crop residues, by-products, pasture, tree fodder and forage crops, and it is this production that requires the highest amount of water (Peden et al., 2007). With increasing demands for livestock products is there an increasing water consumption (Descheemaeker et al., 2010). The production and consumption of livestock products is rising about 2,5-4% yearly in developing countries, in relation to that is rise less than 0,5% in developed countries (Peden et al., 2007). Sub-Saharan Africa was problems with water scarcity, and this are aggravated by the increasing demand for food and water, climate change and environmental degradation (Descheemaeker et al., 2010).

Water requirement of animals adapted to dry land conditions are lower, and therefore they drink less when dehydrated, than animals adapted to temperate conditions (Peden et al., 2007; Wilson, 2009). The native adapted animals also have a high urinary osmolar concentration, which are an indicator of the capacity of the animal to concentrate urine and reduce the water loss through urination (Peden et al., 2007). This means that adapted animals should be better at reduce water loss, and therefore be less dependent on drinking water and be able to withstand dry condition, as oppose to the livestock which are breed for productivity (Peden et al., 2007). The domestication process may also have influenced the livestock in relation to dependence in water and the ability to withstand dry conditions (Peden et al., 2007). So in case of water, a native animal will be the right animal.

The integration of livestock, either fed on crop residues or on grazing rangelands, result in a higher water productivity compared with system without livestock (Harrington et al., 2009). The water productivity is the ratio of agricultural outputs to the amount of water consumed (Descheemaeker et al., 2010). When the water productivity becomes higher, it must be because the output increases more than the water consumed. This can be from the animal products, and a better use of residues, especially if they before was a wasted product.

It is also possible to find a livestock water productivity, which is defined as the ratio between beneficial livestock-related products and services to the water depleted in producing them (Peden et al.,

2007). The livestock water productivity can be increased by improving feed management (feed quality, feed water productivity, grazing and feed type management), animal management (enhance animal productivity, animal health), conservation of water resources and provide sufficient drinking water (Peden et al., 2007; Descheemaeker et al., 2010).

Water also influence where the cattle prefer to graze, because cattle has a preference for grazing close to drinking water (Peden et al., 2007). This has an effect in the farming system with grazing animals, but also with animals in stables. Because this means that the farmer has be provide drinking water to the animals, to sure that they feed.

5. Case study – "The Tigray project"

Ethiopia is a country in the Sub-Saharan Africa, which faces serious problems with land degradation (Belay & Edwards, 2003). In the northern part of Ethiopia is the region Tigray, which is the most degraded part of the country (Araya & Edwards, 2006; Edwards et al., 2010) and has a population where over 85% are farmers (Belay & Edwards, 2003). The farmers in this area has problems with the poor soil condition and therefore struggle to feed their families, they are food insecure, because of low yields of crops (Belay & Edwards, 2003). With this as a basis, the Bureau of Agriculture and natural resources in Tigray (BoANR) together with the Institute for Sustainable Development (ISD) started the project called "Sustainable development and ecological land management with farming communities in Tigray", often referred to as 'Tigray project', in 1996 (Araya & Edwards, 2006; Edwards et al., 2010). The Tigray project is based on the LEISA (Low External Input and Sustainable Agriculture) approach to farming (Lobe, 2008). The LEISA approach advocates point to reverse the adverse effect on the environment from chemically intensive and petroleum-based productions methods (Lobe, 2008). BoANR had earlier adapted a package which was based on varieties with a high input need and chemical fertiliser (Belay & Edwards, 2003). But the costs of the inputs are beyond the purchasing power of most farmers in Tigray, which leads the farmers into the dept trap if the used these inputs (Belay & Edwards, 2003). The Tigray project does not rely on external input, which has to be brought.

The project is running in collaboration between BoANR, ISD, local 'woreda' administration and expert together with the local communities (Araya & Edwards, 2006; Edwards et al., 2010). A 'woreda' is equivalent to a district in the region (Edwards et al., 2010). The main aim of the project was "*to find out if a community-based ecological approach to rehabilitating the land and improving crop production through the application of ecological principles can both reverse land degradation and improve the livelihoods of poor smallholder farmers*" (Edwards et al., 2010), with the main activities as followed (Araya & Edwards, 2006; Edwards et al., 2010):

- Training and follow-op on compost making and use including monitoring crop yield
- Water and soil conservation activities
- Restricting free range grazing and feeding animals from cut grass and branches of woody plants
- Making community ponds
- Small dams and river diversions to catch and hold water for use in dry season
- Promoting and encouraging innovator farmers in water harvesting
- Bee keeping and use of biopesticides based on indigenous knowledge
- Supporting women-headed and elderly families (they are the poorest of the poor) through supplying seeds of spices and training in raisin fruit and forage tree seedlings for sale to their neighbours

- Training unemployed girls who complete formal schooling to equip them with skills for earning an income
- Experience sharing through cross visits
- Supporting the use of new and easy to manage technologies such as treadle pumps.

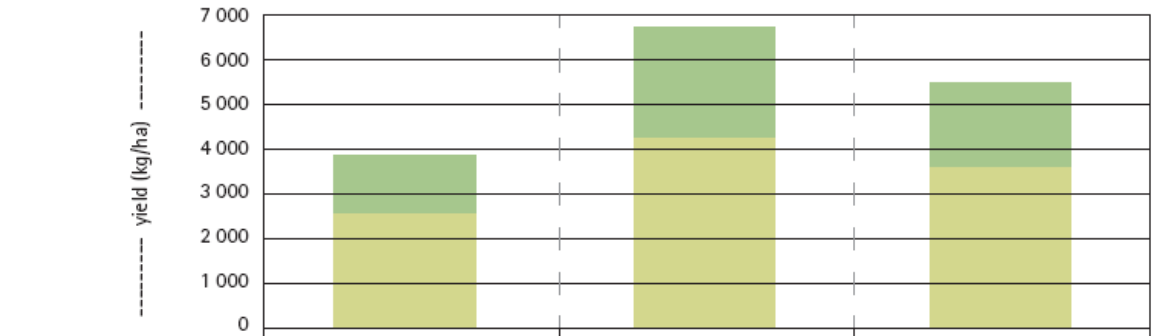
The communities in the project had a 'basket of choices' with suggested technologies that were designed to build on the traditional farming system in the local conditions (Araya & Edwards, 2006; Edwards et al., 2010). Depending on the need in the individual communities, different practices has employed (Belay & Edwards, 2003), so each of the individual starting communities had different entry point to the project (Araya & Edwards, 2006; Edwards et al., 2010).

The project started in four communities and has since been implemented in other communities in the Tigray region and to other region in Ethiopia (Araya & Edwards, 2006; Edwards et al., 2010). This has lead to that fact that 16% of the Ethiopia are cultivated with compost by about two million farm families (which is around 16% of total) (Edwards et al., 2010).

5.1 Crop yields and result from the Tigray project

The performance of the organic system has been monitored, especially the crop yield. The first result from 1998 showed that the crop yield from compost treated plots where similar to chemical fertiliser (Araya & Edwards, 2006; Edwards et al., 2010).

Edwards et al. (2010) made an analysis of the crop yield in the period from 2000 to 2006, and the average yields for grain and straw in seven cereal crops can be seen in Figure 1. The results were that there are differences in the total yield, grain yield and straw yield between the treatments, with the highest yield in compost treated fields. Compost did not only increase the overall biomass production, but the also the proportion of grain to straw in the yield (Figure 2).



	NO INPUT (S=393/G=327)	COMPOST (S=263/G=290)	CHEMICAL FERTILIZER (S=202/G=222)
grain	1 200	2 473	1 812
straw	2 477	4 073	3 404

s=number of observations for straw yield
g=number of observations for grain yield

Figure 1: The average total yield (kg/ha) for cereal crops, based on grain and straw yield from 2000-2006 in Tigray. From Edwards et al. (2010)

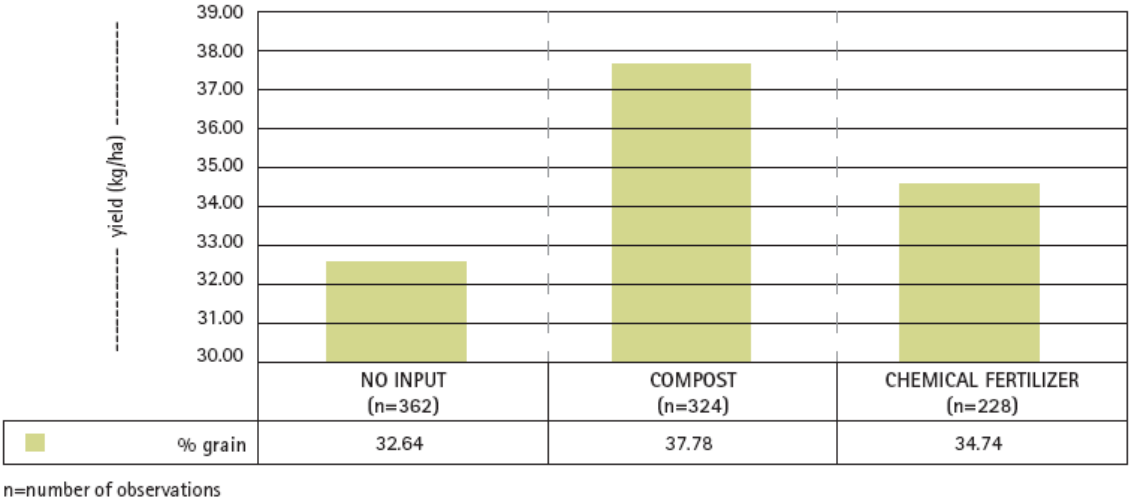


Figure 2: The average grain yield of total yield for cereal crops, from 2000-2006 in Tigray. From Edwards et al. (2010)

For the farmer it was positive that the straw yield was increased from using compost, because the farmers use the crop residues to feed their animals in the dry season (Belay & Edwards, 2003).

The result from 2002 showed, that there were a residual effect from the compost (Araya & Edwards, 2006; Edwards et al., 2010). Results have sown that the residual effect of compost can maintain soil fertility for two or more years (Edwards et al., 2010).

The farmers in this project used their own best yielding traditional varieties, and not the high-yielding varieties, which has a high demand for chemically fertiliser, especially nitrogen and phosphorus (Edwards et al., 2010). Over time the increase in yield level off, which indicate that there is a need for plant breeding for varieties that could respond with higher yields under organic production (Edwards et al., 2010).

The use of compost also had an effect on weeds and pests (Edwards et al., 2010). This is because the composting process destroys the diseases, pests and weed seed, due to the high temperature in the compost heap (van Schöll & Nieuwenhuis, 2004; Inckel et al., 2005). The project also influenced economic and social aspects in the farmer's lifestyles. They did not have a financial burden of buying chemicals, which lead to that several farm, including women-headed, had improved their houses and/or brought additional animals (Araya & Edwards, 2006; Edwards et al., 2010). Some farmers also started with intercropping. The women-headed families, which are generally among the poorest of the poor, also benefited from this projects, because there where focus on this group. This was through start of nurseries for seedling that could be planted out in the fields after the fields are plough by a male (relative or neighbour), supplying seed of spices (a high value crop), having compost workshop, with the participant digging and filling the compost pit, on the farm and making shallow wells and encourage for growing fruits and vegetables for sale (Araya & Edwards, 2006; Edwards et al., 2010).

5.1.1 Livestock

Restricting the grazing of cattle, sheep and goats were the most challenging aspect to implement (Araya & Edwards, 2006; Edwards et al., 2010). This was related to the fact that traditionally it was only the

special animals, like the oxen (plough animal), milking cows and young stock, that get special feeding treatment. The other domestic animals had to forage for their own feed.

The traditional livestock keeping in Tigray has been that animals were turned out in morning and are guided, guarded and driven to communal drinking places during the day by children (Araya & Edwards, 2006; Edwards et al., 2010). There has been a reduction in common grazing areas, because of the need for cultivated fields. The animals has traditionally been allowed to range freely on the harvest fields and in natural vegetation, which affects the environment, because the animals trample on more than they eats, they destroy woody seedlings and break drown physical structures constructed for soil and water conservation (Araya & Edwards, 2006; Edwards et al., 2010).

The restricted grazing or "zero grazing" leads to a need for improved and available forages, because of the change to a cut and carry system (Araya & Edwards, 2006; Edwards et al., 2010). Forage tree are planted around the farm and houses, on hillsides, around gullies and bunds (Belay & Edwards, 2003). This system also means that children does not have to guided animals, and can instead go to school (Edwards et al., 2010).

5.2 Main conclusions from the Tigray project

The result from the Tigray projects showed that the yield could be maintain and even improved when compost is used. The residual effects result in the fact that the farmer does not need to make enough compost for all cultivated land because they can rotate their application for compost. The result from the project is also that the livelihood of the farmers are improved, through no need for buying chemicals and a higher yield, which can lead to food security. The higher yield of straw affects the whole system, because it gives more feed for the animals, which in return will give the farmer more manure, which can be used in compost making or as dried manure, and thereby again affect the crop production.

6. Discussion

The Tigray project is a successful project with good result, and could and is implemented in other communities. The projects build on ownership for the communities, because they decide which of activities that should be started in their area, based on their needs. When the farmer starts to see the outcome of the activities, it can give the farmer and the community's empowerment to continue and start other activities. The project had a positive effect on the livelihood of the participants, because of higher yields, improved income, food security and the fact that they were not dependent on external inputs to the farm. This is some of the benefits from the project.

In relation to livestock and integration of them, the farmers restricted the grazing and started cut and carry, instead of the freely grazing system they traditionally had. In relation to nutrient recycling it is beneficial to have the animals under controlled conditions so the farmer can collect the manure. The integration of livestock will also means that the crops residues can be used, in the Tigray area the residues where already used to feed the special animals, so the cut and carry system creates a need for more forage feed. The need for more feed for the animals leads to planting of forage tree, which can give shade on the farm and effect on the water holding capacity. The cut and carry system, provide the farmer with the opportunity to improve feed and animal management, which can lead to better livestock water productivity.

The project is based on the local conditions and what the farmers already have. So the livestock in this area would supposedly be local adapted breeds, so the conflict of having animals that are not

adapted to the environment, should not be the case here. The best solution is to have livestock that are adapted and can handle the local environment and conditions. It should also be animals that can perform well under the provided condition, so the farmer will get a high return from the animals, either as yields, power or other things. An animal that are native, will have a reduced water loss and need compared with an exotic breed, so this will also benefits the water productivity.

The restricted grazing and the cut and carry system is the part of the projects, which gives most conflicts with the organic principles, because this system restricts the animals from during their natural behaviour, which is browsing. In the traditionally system of freely grazing, the animal are allowed to perform their natural behaviour, but the animals are instead putting a pressure on the local environment. Because the animals will eat and trample on the natural vegetation, which can lead to low regeneration of trees because saplings are destroyed and in general can overgrazing leads destroyed vegetation, which leads to degradation and erosion. So in both systems are there conflicts that have to be considered. Is not either having the animals freely grazing or zero grazing with cut and carry; there is also alternative system which could be used. Based on the organic principles the animals should be allowed to perform their natural behaviour, and the system should be based on local conditions, so an alternative system should consider those things. It is important that the system is supported by the local conditions; otherwise it can give problems to the farmer.

An alternative system could be a system where the animals are kept in stables at night time, which give the farmer control over the manure produce in that period, and in day time have the animals out grazing. The animals can after harvest grass on crop residues, which could be stubbles, in Tigray the region the farmers usually leave long stubbles from cereal field, so that the domestic animals can graze on them (Edwards et al., 2010), and general residues which are not collected, on smaller plots. This will require a kind of fence system or a tethering system. The fens can been a living fence, with forage tree or other plants that can be useful. The farmer can choose to collect the manure from the field or leave it there and incorporate it.

7. Conclusion

The integration of livestock into the whole system both gives benefits to the system, but is can also result in conflict according to the organic principles. The benefits are that the animals will be a part of the nutrient cycling on the farm, trough the manure and their ability to utilise crop residues, and could provide the farmer with draught power. The conflicts are related to housing condition, is the animals in stables day and night, freely grazing or in an alternative system, and in general which species or breed used in the system, which also have an effect on the water productivity. If integration of crop and livestock is done with the right animal it will provide the farmer with benefits, like yields of milk and meat, draught power and the possibility of sale for cash income, all thing that have an impact on the livelihood of the farmer. But the housing system will be a place where there will be a compromise between natural behaviour and the wish to have the animals in a controlled environment.

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