December Report: Okwagaanana Uganda

Academics for Development

Team

Lara Helsen, Amadeo Hachez, An-Sofie Tas, Viktor Cockx, Joshua Beyers, Line Van Bossuyt

Coach

Ignace Pelckmans

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Content

Introduction

More than just an organisation, ‘Okwagaanana’ or “meeting one another” in Ugandan is a meeting of minds premised on the conviction that progress is achieved through social interaction and diversity. By empowering young individuals, Academics for Development (AFD) aims to draw upon enthusiasm and talent to create innovative responses to real-world problems.

The cooperation between Okwagaanana and AFD is rooted in this message of hope and creativity. The goal of the project is to help the Kidiki School in Namwendwa, Uganda, to become financially sustainable and as such, allow it to extend its educational offer to Ugandan students. It is our strongest belief that this project will be as enriching to us as to our Ugandan partners.

At the heart of the project are six driven students, eager to have a lasting impact on the world. Persuaded that a diversity of competences is the key to innovation and creativity, the AFD team is composed of a variety of profiles with backgrounds in physics, engineering, biology, economics, sociology and education. It is our strongest belief that by joining our efforts, we will be able to fill the gap between ideas and action, and have a lasting impact on the Namwendwa community.

This report presents our current situation in realising the Okwagaanana project; how it emerged, what it consists of, and where we, as a team, want to go in the future.

Enjoy the trip!

An-Sofie, Lara, Line, Viktor, Joshua, Amadeo

Chapter 1. Project summary

1.1. Partner description

After their trip to Uganda and more precisely, the village of Namwendwa, Jos Kuppens and Frieda de Lannoy fell in love with the country. When returned home, they felt the urge to help the people of Namwendwa in the further development of their community. In 2007, they decided to support a project called “Okwagaanana”. As a result, a Belgian branch of the already existing project was established. This branch is an autonomous sub-organization of the non-profit organization Don Bosco and is run by volunteers only. It primarily obtains its funding through institutional sponsors, crowdfunding or third parties and collaborations with external partners.

“Okwagaanana" stands for “meeting each other” and it focuses on three initiatives in the village. The Kidiki Primary and Secondary School is one of them and this will also be the focus in our project. The main goal here is to make the school financially independent and the implementation of an A-level accreditation. The second initiative is the Kyebajja Tobona Women’s Group (KTWG). Its goal is to stimulate responsible and efficient microfinancing among the local women and to empower them in general. Third, the vocational training centre’s goal is to provide agricultural training for the local farmers (*Okwagaanana*, n.d.).

1.2. Initial project content

Uganda’s educational system disposes of multiple levels of accreditation. An educational institution can award legally recognized degrees for each level up to a specific year of study. The Kidiki secondary school is currently allowed to award legally recognized degrees up to the O-Level, which is equivalent to the fourth year of secondary education. Secondary education in Uganda consists of a total of six years of study. Only with the A-level accreditation can an educational institution award degree for the fifth and sixth years of secondary education.

Obtaining an A-level accredited degree is of primary importance for Ugandan students as this degree allows them to apply to continue study at a higher education institution. Kidiki School’s students face significant difficulties to access to A-level accredited institutions in the region, thereby limiting the prospects for further education and a bright future. The main barrier to achieving A-level accreditation at Kidiki secondary School is financial sustainability.

The cooperation between Okwagaanana and AFD aims to solve this issue, as both organisations believe doing so will have a positive and lasting impact on local communities. Besides allowing local students to pursue higher education, A-level accreditation could also attract students from nearby villages. These educated students can thereafter bring back their knowledge and skills to the local villages and contribute to the development of Namwendwa sub county.

By providing the school with solutions to allow more efficient expenses and reach financial profitability, AFD hopes to set the school on the right tracks and ultimately grant it financial independence. This will be done in accordance with social and community concerns in Namwendwa. Local individuals, businesses, communities and other NGOs should all be considered as potential partners in this ambitious undertaking.

Chapter 2. Preliminary research & problem statement

2.1. Local context

2.1.1. Geographical context

Uganda is divided in 77 districts, spread over four geographical regions: North, East, West and Central. The Kidiki Primary and Secondary School of Namwendwa is located in the Kamuli district, in the Eastern part of Uganda. (Government of Uganda, n.d.)

Namwendwa's population is estimated at approximately 65 900 and has an area of 150 km² (Brinkhoff, n.d.). The inhabitants of Namwendwa mostly speak Lusoga, mixed with a bit of Luanda and English. In Uganda, 78 percent of the working population are working in the agricultural sector (Uganda Bureau of Statistics, 2017). The same trend is visible in the district of Kamuli. Over 92 percent of the households are engaged in growing crops or livestock farming and 86 percent grows maize (Uganda Bureau of Statistics, 2017).

The temperature in the Kamuli District typically varies from 16°C to 35°C, throughout the year. The Kamuli District region has an annual bi-modal (two rain and two dray seasons) rainfall that ranges between 900 mm and 1500 mm and has two growing seasons. During the first growing season, most of the rains are received from March to May/June, and in the second one from August to October. Important is that in the second growing season less rains are received than in the first growing season. (Tusiime, Nonnecke & Massinde, 2019)

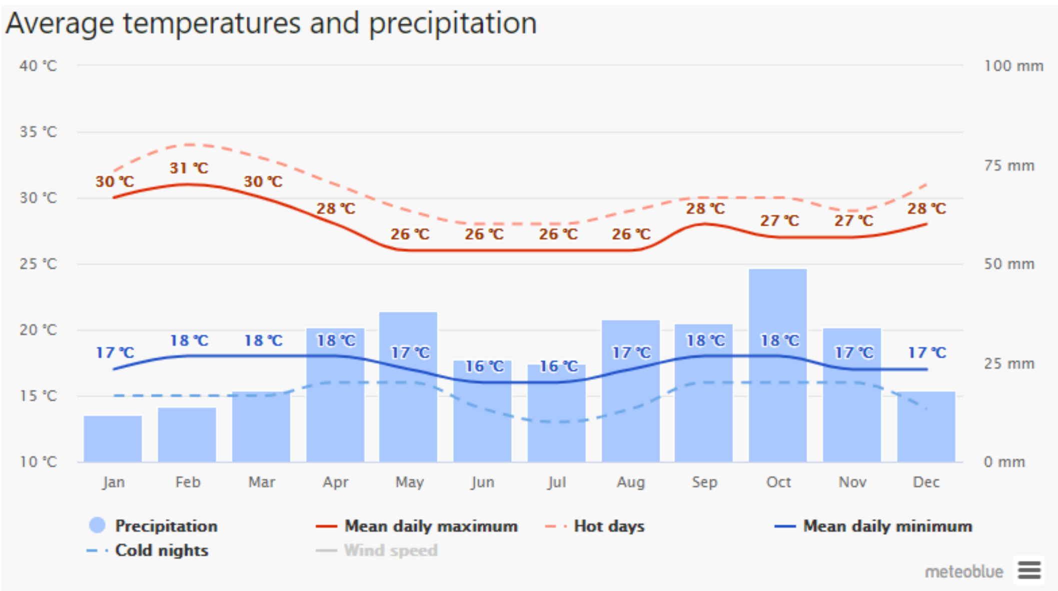

Figure 1. Average temperatures and precipitation. Retrieved from *meteoblue*, n.d. Retrieved from https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/ kamuli _uganda_232397. Copyright n.d., Meteoblue.

Namwendwa is a relatively small municipality. Nearby towns are Kamuli, Buyende, Buwenge and Kaliro. These are about 15 to 40 km away from Namwendwa. The closest rivers (Kiko River, Lake Kyoga, Lumbubvri River and Nabigaga River) are at a distance of 20 to 40 kilometres. (Google Maps, 2020)

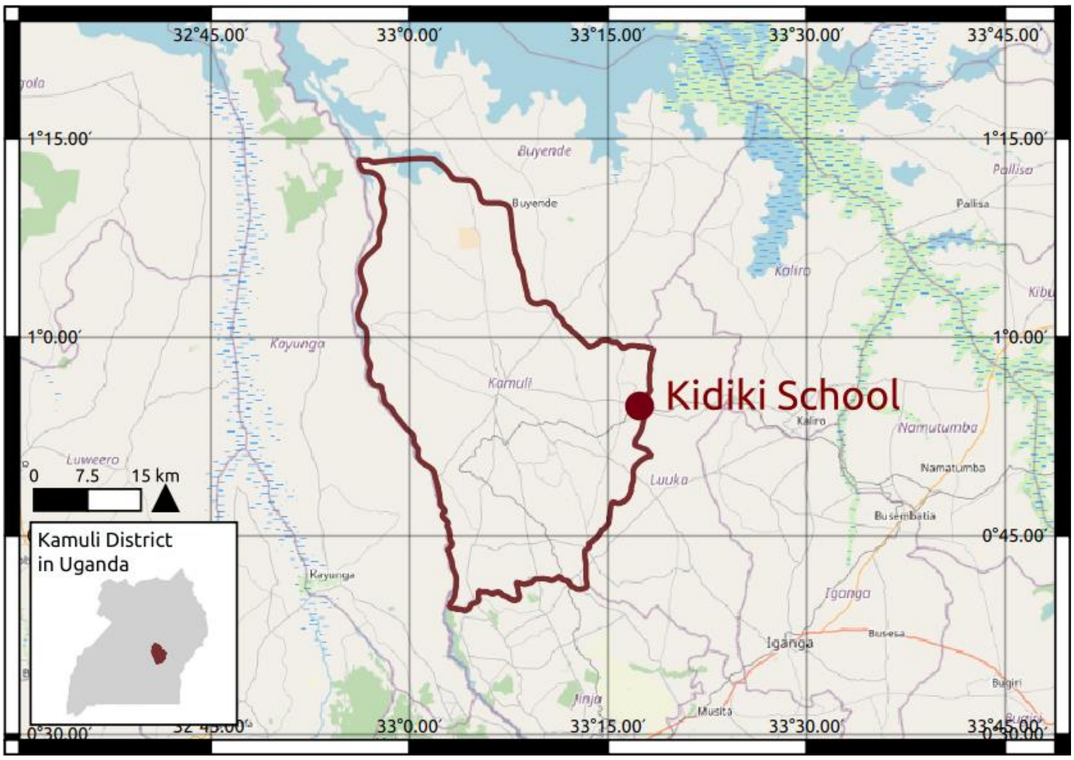

Figure 2. Lokalisation of the Kamuli District and the Kidiki Primary School. Retrieved from OpenStreetMap, n.d. (https://www.openstreetmap.org). Copyright n.d., OpenStreetMap.

The dominant soils in the regions are sandy loams (SL) and clay loams (CL), which describes the relative proportion of different grain sizes of mineral particles in a soil (Tenywa et al., 1999). Frequent irrigation and fertilization are necessary to maintain healthy growth in a sandy loam soil (Thompson, 2018). According to the WRB, these soils can be classified as petric plinthosols and ferralitic soil, indicating the presence of rather acidic soils, which are poor in nutrients, and therefore quite infertile (Kaizzi, Nansamba & Kabuye, n.d.).

2.1.2. Current situation Kidiki School

As mentioned above, this project will focus primarily on supporting Kidiki school becoming financially self-sustainable. Hence it is important to understand the current situation of the school more in-depth.

The school is private and started off in 2004 with six students, 11 teachers and two non-teaching staff members. Over time Kidiki expanded and currently counts 300 pupils, 21 teachers and seven support staff members. The school receives children from all over Namwendwa and its broader area. (Background – Kidiki Secondary School, n.d.)

During the years, also the school's infrastructure expanded. Three new classrooms, a teachers' room, a library and a department for a kindergarten have been added (Okwagaanana, n.d.). Some of the pupils attending classes in Kidiki are boarding school pupils. Therefore, one of the buildings provides sleeping accommodation for them. During the day, the pupils are offered meals prepared by the staff. The kitchen is equipped with a single open fire stove which requires a lot of expensive wood, leading to many financial losses. Additionally, the school owns six cows and several chickens. During the spring of 2020, school staff succeeded in growing dozens of tomatoes, an achievement which they would like to pursue in the future. Concerning access to (drinkable) water, the school faces significant difficulties. They own one water tank of 10 000 liters which, when full, can only be used for three days by the students. When empty, the school can access tap water. However, this water source is not reliable frequent blackouts turn off the pump to provide this water. If no water is available in the school, children need to walk 20 minutes in order to reach a water source (M. Walekaki, personal communication, November 17, 2020). Given these limited sources of water growing crops adequately is a big challenge in the area during the dry seasons.

At present, the main source of income are the tuition fees the pupils need to pay, which was each trimester 158,745.21 shillings (36 euros) for daily students and 317,490.41 shillings (72 euros) for boarding pupils last year (AFD, 2020). These revenues need to cover a much wider range of costs which consist of salaries, food and fixed costs. As a result, the school runs deficits or at times slightly reaches the break-even point. Besides, it is only able to organise education at the O-level. Since pupils need to accomplish all the six years before starting any further education, the O-level causes a major limitation to the pupils' future and to the development of the entire region in general.

2.2. Problem statement

The main goal of Okwagaanana regarding the school is to provide qualitative and future oriented education to the youth of Namwendwa. This objective however, is challenged by the lack of sustainable income. Due to the bad financial situation, the school is not able to operate at the A-level. As such, pupils are restricted a lot in their opportunities to enroll themselves for any kind of further education. In a local survey, this came out as the main blockade in the development of the whole community. In order to provide the A-level, the school's financial situation needs to ameliorate, especially they need to become financially self-sustainable. Hence this is the main goal of the project.

Chapter 3. Leads

Building on the foundations of previous research and through active brainstorming and consultation with the local partners, several ideas have emerged as viable and impactful for allowing Kidiki School to become financially sustainable.

One of the first conclusions was that Kidiki School's expenses should be cut, or/and a sustainable source of revenue should be integrated into the school's management. For this purpose, several propositions were assessed. These include: setting up an irrigated cropping system allowing the production of crops all year round; developing the school's livestock through innovative food compositions for increased milk yield; reducing energy losses in Kidiki's kitchen by introducing new types of firewood or purchasing a more efficient cooking stove.

After several meetings to assess the viability of these projects, the need to fully concentrate our efforts around one or two major projects emerged. Most importantly, the idea of integrating irrigated crop production in the school's authority was discussed and approved by us, the local partners, and the Okwagaanana non-profit organisation. Besides, the idea of reducing the financial expenses of Kidiki's kitchen by increasing its rentability through more effective firewood and reducing the need to purchase livestock fodder has also been explored.

Building an irrigation system for all seasons presents the potential for positive spillovers for the Namwendwa community as it could be integrated into the pupils educational package at Kidiki School to develop independent set-up capabilities for the surrounding villagers. In order to build an irrigation system best-suited to local means and demands, a comparison between different crop types has been conducted and corresponding water demand has been analysed. Given its immense long-term benefits and low costs, the idea of introducing Agroforestry to

Kidiki School as a means to increase long-term crop yield has also been investigated upon. Improving the milk production of Kidiki's livestock appeared as a viable measure with rapid impact. Initially, the aim was to allow for an alternative source of revenue via selling milk on the local market. Improving the production of milk would thus provide a direct revenue for Kidiki School. After a reunion with the school's authority, we came to understand that the milk is used solely for own consumption in the form of meals for students. However, we have decided to pursue this lead as increasing milk production induces a reduction in fees for meals, as well as a diversification of the students' diet. The impact is therefore twofold.

Finally, ideas from AFD's previous team to improve the efficiency of the Kidiki kitchen and lowering health risks of local staff by providing the school with a more efficient stove have been extensively discussed and analysed. Our assessment is that while these ideas are worthy of consideration and highlight existing problems in Kidiki School, AFD's limited financial budget points to the need to focus on agriculture, agroforestry and increasing milk production. Doing so will allow a more direct and cost/efficient contribution to ensuring Kidiki School's financial sustainability.

We believe the implementation of the outlined leads will allow a significant contribution to making Kidiki School financially sustainable and will set the stage for future AFD teams in realizing this goal.

3.1. Crop production

3.1.1. Initial lead

As mentioned in the introduction of chapter 3, an irrigation system has to be worked out in order to grow crops in all seasons. This includes the dry season when water is scarce. Hence, it is of great importance to do a proper study about the possible amount of water needed when growing crops in local conditions. Optimizing water demand and plant growth using agroforestry will also be discussed.

3.1.2. Research and development lead

3.1.2.1. Which crops

In the past, tomatoes have been grown successfully at the school. However, this growth was during the wet season when water was hardly a problem. When a growth during the dry season is the objective, other crops that possibly use less water can be interesting. This, on top of the fact that the local partner would like more variety, forces us to look at more than 1 crop. Through contact with the local partner it has been made clear that the community also considers onions, spinach and eggplant as an addition to tomatoes. The partner has experienced that the soil and water demand of these crops fit the best with the local environment and these crops could be used as "cash crops". Cash crops are crops which are primarily grown to sell for profit.

When overviewing these four options, there are a lot of factors to consider. The most important ones are: Price/kg, kg/ha, growth time and Crop coefficient. The Crop coefficient as well as the growth time are two parameters directly linked to the amount of water a crop need. These two factors will be discussed in the section about the water demand. Price/kg and kg/ha can be combined in the factor price/ha. The value of these factors can be found online (Hello Fresh Uganda, 2020; Wikifarmer Editorial Team, 2019a, 2019b, 2020; Yewendwesen Bikila & Van Hall Larenstein University of Applied sciences, 2012) but we need to be cautious: These are very rough estimates and are given for optimal growth and land use. This means the values have to be further refined to be representable for this project, but it already gives a good comparison between the crops.

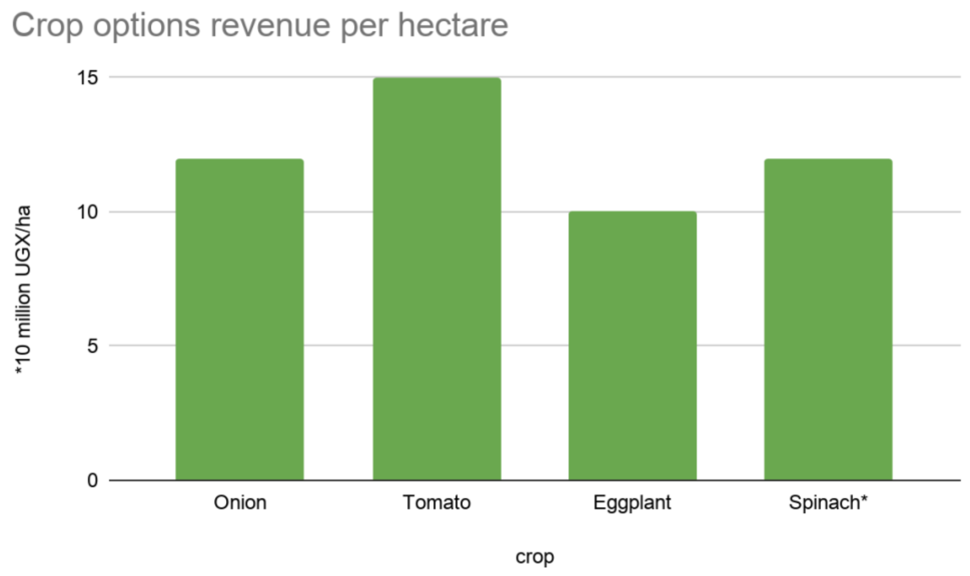

Figure 3. Revenue per crop per hectare comparison

* estimated 500gr per bundle spinach

3.1.2.2. Water demand

Rough calculations for water demand have been made for the four different kinds of crops. These were made for two harvests per year with the growth period centred around the dry season. The calculations were based on the Food and Agriculture Organization (FAO) Guidelines for computing crop water requirements (FAO, 1998). A weblink for the calculations document can be found in annex II. The results of the calculations can be summarised in a diagram.

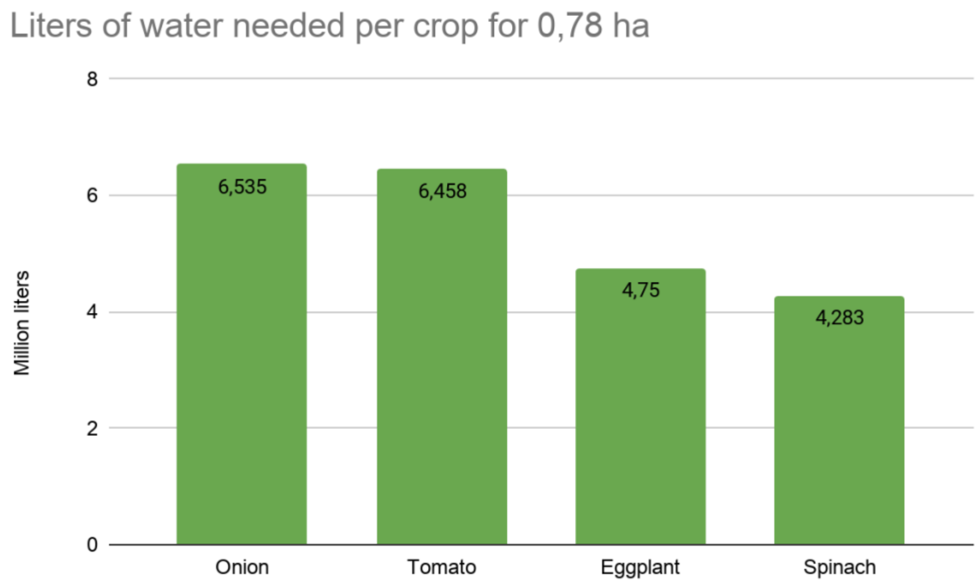

Figure 4. Litters water needed per 0,78 ha for two growths per year comparison

First of all, these numbers are the litters needed if the whole field (0,78 ha) would be stacked to the fullest with the crop. Secondly, general crop coefficients have been used. A crop coefficient is a number depending on the type of crop and several other factors. This number is multiplied by the reference evapotranspiration "ET0" which is solely determined by environmental factors. The crop coefficient can be further adjusted using environmental data and depending on the type of farming. Also, it has to be mentioned that the different crops have different growth times. Growth times according to the FAO can be seen in the diagram below (FAO et al., 1998). There is a minimum and maximum growth time depending on the region of growth.

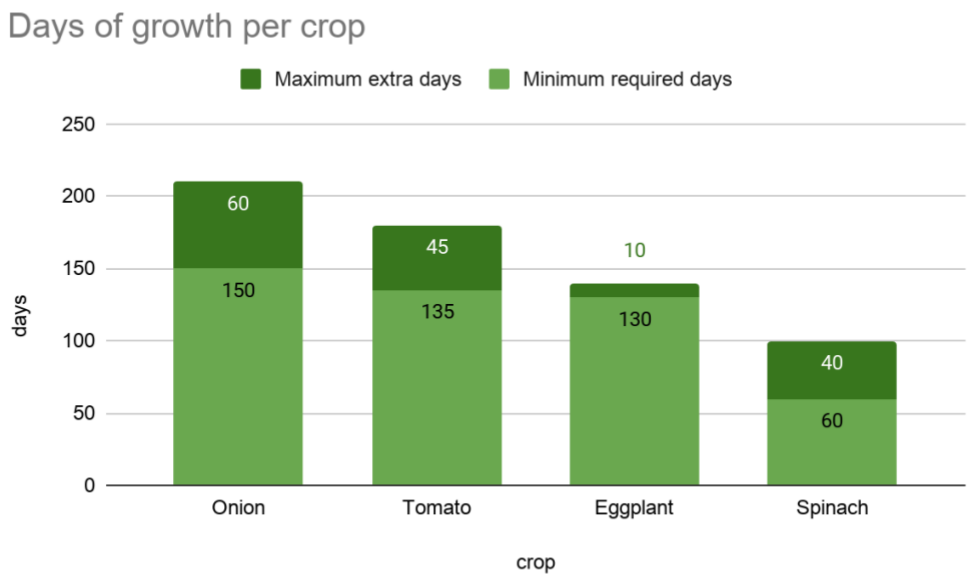

Figure 5. Days of growth needed comparison

In conclusion we can say that many factors come into play when determining the amount of water needed. Former calculations were done pretty much manually. Luckily there is a solution to this, the FAO has online tools for calculating water demand more into detail (FAO, 2020b, 2020a). In the further elaboration of this project, we will be using those tools.

3.1.2.3. Agroforestry

We want to implement the concept of agroforestry on the crop field to increase the crop yield in the long term. Agroforestry is the integration and management of trees and woody shrubs with crops or livestock. It can be categorized into two classes: simple agroforestry systems, where crops are placed in alleys between the trees and complex agroforestry that resembles a natural forest (Mbow, Smith, Skole, Duguma & Bustamante, 2014). For the Okwagaanana project we would use the simple form because of the space limitation and as we should keep the main focus on the crops the partner wants to grow.

Several advantages have been attributed to this way of farming. The most interesting advantage for the project is the possibility to improve the moisture of the soil. The root system of the trees will modify the structure of the soil by reducing soil compaction. This will affect the water retention and infiltration in a positive way (Rosenstock et al., 2019). By the shade they create, trees can also have a cooling-effect, which will lower the evaporation and hence improve soil moisture as well. Furthermore, the litter layer, formed by the trees, captures rain that otherwise would be evaporated or lost by run-off and so improves water infiltration (Zhu et al., 2019). As access to water is limited, loss of water is the main problem that must be overcome to improve the crop yield in the Okwagaanana project. We are convinced that by implementing agroforestry on the crop field the water demand will be significantly lowered. Therefore, agroforestry can be part of the solution.

Another interesting advantage of agroforestry is improved nutrient cycling. Trees can take up nutrients that are located deeper in the ground and hence, make these available for crops by litter and root decomposition (Rosenstock et al., 2019). Leguminous trees in addition can improve nitrogen composition because of their ability to do biological nitrogen fixation (Mbow, 2014). In conclusion, trees will improve the fertility of the soil. Furthermore, we want to plant fruit or fodder trees which can yield valuable products immediately that could be sold or used for own consumption. The impact of these trees will go a lot further than lowering the water demand and the school will also reap the rewards of the extra benefits. It will keep the soil healthy, assuring a sustainable yield in the long term and it will provide extra products like fruit and fodder, lowering food costs and diversifying the diet. Lastly, more overall advantages can be attributed to agroforestry like reducing soil erosion, climate mitigation and improving biodiversity (Rosenstock et al., 2019). The trees can even improve the working conditions by providing a pleasant shade.

To make agroforestry succeed, it will be important to choose tree species that are complementary with the crops that will be cultivated. The competition for water between the trees and crops should be minimized and we will do further research on this topic in the next few months. Our current plan is to use a combination of fruit trees and fodder trees. We will discuss with the local partner which fruits are most valuable to them and according to this make decisions about the type of fruit trees that can be used. Not all plants are able to grow in the shade, especially crops that produce fruits like tomatoes and eggplant prefer a lot of sunlight. Onions also grow best in full sun. Leafy crops, like spinach on the other hand, can perfectly grow in the shade. The reason for this is that plants that grow in the shade will invest more energy in expanding their leaf area to optimize their photosynthesis ability (Smith, Savage & Mills, 1984). Hence, this will be a problem for fruit producing crops, making the yield less optimal. It will be important to keep these light preferences into account when organizing the farming field. For the fodder trees we already have a specific species in mind, namely *Calliandra calothyrsus,* which is interesting because of its high protein composition and its compatibility in agroforestry systems (Place et al., 2009). This will be further discussed in our third lead (3.3. Cows). Correct management of the trees is also an important factor to the success of agroforestry. For example, the timing of the pruning of the trees can have a big effect on the water demand (Jackson, Wallace & Ong, 1999). This topic will also be further investigated in the upcoming months.

We are convinced that agroforestry can improve the crop yield at a low cost and that the effect will be felt for a very long time making it an achievable and sustainable option.

3.1.3. Impact of the lead

Thorough investigation of all the factors that influence crop growth gives us a better chance to optimize the amount of resources needed to grow crops. The impact of this lead will be a more efficient water plan and positive side effects from agroforestry. This will lead to less costs and as a consequence; larger profit. The water demand is also vital information for designing the irrigation system.

3.1.4. Conclusion lead

In the second semester of this project, a more detailed irrigation scheme will be worked out. Up until now the water calculations were very rough to say the least. The calculations were for 2 growths per year in certain periods and for a full field. In the future we will be dividing the field to grow different crops in varying periods to optimize the use of resources. Thereafter, the maximum amount of water that needs to be gathered at one moment in time can be calculated. Subsequently a solution for gathering this amount of water can be thought out. The impact of agroforestry will also be measured and a plan for the implementation of it will be made.

3.2. Irrigation

3.2.1. Initial lead

As the previous section has proven, water is key for a sustainable production of crops all-year round. Therefore, watering the plants in such a manner that water losses are as low as possible, is essential. An ideal way to use water efficiently during farming and minimize water losses is through irrigation. Irrigation would support farming during both farming seasons and would grow the crops described in previous sections to help the Kidiki school become financially independent. So together with the ideas given in previous sections we can explore different ideas to irrigation.

3.2.2. Research and development lead

3.2.2.1. Kinds of irrigation

To be able to find out which kind of irrigation system would be best suited for the Kidiki school, the type of soil should be determined. If we look back at the local context, the type of soil that can be found in the Kamuli district are sandy loams. Surface irrigation is not optimal on this type of soil because of the high infiltration rate of sandy loams. On the other hand, drip irrigation and sprinkler irrigation would be smarter to use because water loss due to surface runoff and deep percolation is minimal with these methods. In the drip irrigation system, water is applied very locally at the plant root area while sprinkler irrigation reaches large areas of the field and applies water equally and frequently in ideal circumstances. To be able to choose the right method of irrigation we must look at the two favourable but different methods. (Alhammadi, 2013)

Sprinkler irrigation

Sprinkler irrigation is a method where water is distributed by overhead high-pressure sprinklers or guns from a central location in the field or from sprinklers on moving platforms. It is easy to set up and there is no requirement of having a lot of sprinklers as the sprinkler is movable. In wind-free conditions and if installed properly, thus in ideal circumstances, water is distributed equally and is frequently applied to the crops. The amount of supplied water can be controlled and the sprinkler can be used for other functions as well, for example using as cooling during high temperatures. The investment cost for purchasing the equipment is high compared to other irrigation systems. Moreover, this kind of irrigation system needs a constant water and energy supply to get high pressure on the sprinkler. Besides, there is a chance of evaporation loss in windy conditions and a chance of water loss when it is high in terms of humidity. As such, this method of irrigation is not so favourable but could be a system used in the future when the Kidiki school is financially stronger. (Civil Engineering, n.d.)

Figure 6. Sprinkler irrigation. Retrieved from Kabunga, 2016. Retrieved from https://agriprofocus.com/post/57e80572a93f254eb659cdb7. Copyright 2016, Agriprofocus.

Drip Irrigation

An alternative to sprinkler irrigation, is drip irrigation. Drip irrigation provides a maximum efficiency level and a minimum level of water loss. Moreover, extensive land levelling and bunding is not required because it prevents soil compaction (Bernstein & Francois, 1973, p. 82). On the other hand, it requires a high initial investment and regular replacement of ground equipment due UV-radiation or clogging of the tubes (Bernstein & Francois, 1973, p. 82). The whole idea of our project is to make sure the Kidiki school becomes financially independent, regular replacement of system equipment would not be favourable, so we looked for drip irrigation that would be at a lower cost.

Drip irrigation using plastic bottles is a method that would be low in cost but quite labour intensive as the use of plastic bottles would be needed in a big quantity. It does give us an eco-friendly (recycling) method that is cheap and if done correctly, reliable. There are two ways to use plastic bottles for drip irrigation (Brown, 2020). Firstly, the plastic bottle is placed in the ground and secondly, the bottle is settled-up above the plant. Both methods rely on cutting the bottom of a 2L plastic bottle to insert water. However, both of these techniques bear to many disadvantages like clogging, high work intensity, attracting mosquitos etc. Figure 7 shows those two methods. (Brown, 2020)

Figure 7. Bottle drip irrigation (left): left in ground, n.d. Retrieved from https://homesteadlifestyle.com/diy-goteo-solar-drip-irrigation/. Copyright n.d., Homestead Lifestyle

Figure 8. Bottle drip irrigation (right): hanging above the crops, 2020. Retrieved from https://thelogicalindian.com/uplifting/farmer-uses-waste-glucose-bottles-to-build-drip-irrigation-system-22660. Copyright 2020, The Logical Indian

Bucket drip irrigation is an idea that looks promising, fulfilling our need for a cheap but efficient drip irrigation system. It is a low-cost method that delivers adequate amounts of water to crops in an efficient way both in terms of labour and quantity of water used. The system is locally assembled using an ordinary plastic bucket and drip lines, the latter being plastic tubes connecting the bucket with emitters through which water can 'drip' onto the soil. All of these materials are readily available in shops selling farm equipment. The buckets serve as the reservoir and are raised to a height of 1m to allow water to flow to the plants by gravity. A representation of what this would look like is presented on figure 9 below. (Mafabi, 2018)

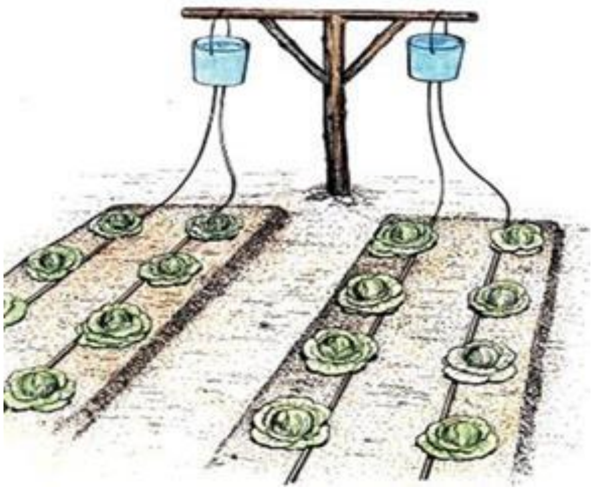

Figure 9. Bucket drip irrigation. Retrieved from Pinterest, n.d. Retrieved from https://www.pinterest.com/pin/244672192229512146/. Copyright n.d., Pinterest.

3.2.2.2. Choice of irrigation system

After considering all the options described above and their advantages and disadvantages, we concluded that the bucket drip irrigation system was the most favourable of them all. Bucket drip irrigation is a low-cost solution that not only reduces the work intensity of the plastic bottles but also provides a less expensive alternative and is easy to maintain and operate next to the expensive sprinkler irrigation systems. The bucket drip technology uses gravity fed irrigation lines that convey water to the individual crops. To understand how efficient the bucket drip irrigation will be, we should explain a bit more about drip irrigation itself. Drip irrigation supplies water to the soil very close to the crops/plants at a very low flow rate from plastic tubes with outlets. This way a wet bulb of soil lies develops, close to the roots so the crop can effectively suck up the water. Areas in between crops are barely watered and so water is not spilled. Drip irrigation brings more efficient water use and reduces the cost of fertilizers because of the increase of absorption of the nutrients, which the crops need for growth, and decrease of losses. Not only is there reduced labour demand as water is distributed uniformly, drip irrigation requires less energy than a conventional system. (Karlberg, Rockström, Annandale, & Steyn, 2007)

The components of the bucket drip irrigation system obviously start with a bucket, usually a plastic bucket that should hold about 20 litters of water. A hole must be cut in the bottom of the bucket to insert an adapter, so water flow is possible. The bucket should be held 1m above the ground to maximize the pressure for the drip lines. To do this the bucket could for example be placed on a stand, but the bucket should be secured so that high winds would not knock the bucket over. A bucket adapter is then used to connect supply tubes with the bucket. A filter screen is attached to filter out stones or any sandy particles in the bucket. The supply tubes connect the bucket to the header tape and should be longer than 1.5m because of the stand height of the bucket. One end is connected to the adapter and the other end is then connected to the connecting tubes who connect all the previous parts with the drip emitters. (Ashraf, 2016)

To use the bucket drip irrigation system at its full potential the soil should be irrigated before planting the seeds to get precise planting locations and fertilizer can be used (Ashraf, 2016). Depending on the type of crop, the demand for water should be planned and given accordingly. How much water is calculated at one of the focus points (3.1.2.2 water demand) of this December report. Water should be applied early in the morning or late in the evening, this is done to minimize water loss due to evaporation and cooler water reduces stem elongation (Chen, Sun, & Sheen, 1999, p. 852). In the Annex II of the report a figure is shown where general guidelines for the frequent maintenance on a daily, weekly and monthly basis of the irrigation system are given (Ashraf, 2016) together with an installed bucket drip irrigation system. To conclude we could say that the drip irrigation system will be the most suitable and should be held at a good watering schedule, together with a good field layout design and maintenance of the system.

3.2.3. Impact of the lead

The school should benefit greatly from selling a part of the crops they will harvest. Kidiki would also like to improve the variety of the student meals, by keeping a part of the crops they farm. Not only will the irrigation system have a financial impact on the school but if managed correctly, it could be incorporated into the educational curriculum of the school. This way, it could contribute to the agricultural development of the local community as such. An economically growing community in its turn would then lead to more revenue for improvement for the Kidiki school which will then further improve the education with A-levels.

We shouldn’t forget possible pitfalls which should be avoided to maximize our impact. The whole idea of the irrigation system is to make it easier to farm the land they have and not put too much weight on the shoulders of staff or students who will be helping maintain the system. The educational aspect of the irrigation system should remain education and fun for the students and not feel like work for them. We should also be very certain on which crops to grow and sell because if Kidiki won't be able to sell the crops with profit, Kidiki will not make progress in order to become financially independent. Next to all these points we must not forget to include the Namwendwa community in the project as well.

3.2.4. Conclusion lead

Further research on drip irrigation and available kits should still be made but a good overview of the idea is already made. Together with further aspects of the report, a complete workout of the lead will be made in the future.

3.3. Cows

3.3.1. Initial lead

The local partners are also interested in focusing on improving their dairy production. The produced milk is used for own consumption and therefore it will not generate any direct income. Nevertheless, it is valuable because it can diversify the diet of the students and lower the food cost of the school.

The school currently has six cows of the Friesland breed type. Two of the six are adult female cows that are pregnant at the moment, so they can be used for milk production soon. However, the milk production in the past has been rather low. We want to raise the production by improving the diet of the cows. The local partner uses a combination of grazing on pastures and keeping the animals in a stable where they are fed fodder. When they can keep an eye on the animals, they let them graze and otherwise the cows stay in the stable. The fodder that is used by the local partner only consists of hay. This hay is bought externally and costs them between 300 000 and 400 000 shilling (68-91 euro) a month.

3.3.2. Research and development lead

Buying fodder supplements is expensive and as we want to make the school more financially stable, adding expenses is not desirable. We looked at options for the Kidiki school to produce their own fodder supplement to make improvement at a low cost. Fodder trees turned out to be a great option because they can grow along the crops, so they are not taking up extra land, and only a very small amount of labour is needed for the maintenance of the trees.

One particular species caught our eye, namely *Calliandra calothyrsus.* This is a leguminous shrub that is widely used in east Africa by small dairy farmers to produce their own fodder. Leguminous trees are especially interesting because of their ability to fixate nitrogen. Because of this accumulation of nitrogen in the plants, they have very high protein concentrations making them suitable supplements for cow fodder (Place et al., 2009). On top of this, nitrogen fixing trees are interesting to use in an agroforestry system because of their potential to enhance the nitrogen concentration in the soil. Figure 9 shows Calliandra in such an agroforestry system. We want to implement this combination of trees and crops as explained in the first lead (3.1.2.3: agroforestry) and so with this species we can be hitting two targets with one shot. Further, it is a great supplement to the general diet not only because of its high protein concentration but also because of its ability to improve digestion and nutrient uptake from hay (Camero & Franco, 2001). Other fodder trees grown in east Africa are *Leucaena diversifolia* and *Sesbania sesban*. These trees have higher concentrations of protein but are more difficult to maintain and less resistant to pruning, making them less suitable than Calliandra (Place et al., 2009).

Figure 10: *Calliandra calothyrsus* in an agroforestry system, (Shelton, 2020)

Under normal conditions, the Calliandra shrubs should be ready for pruning after 9 to 12 months and pruning can be repeated 4 to 5 times a year (Place et al., 2009). In this way approximately 1.5 kilograms of dry matter (or 4.5 kg of fresh plant matter) can be yielded from one tree each year (Place et al., 2009). The plant matter can be fed fresh or dry and its nutritional value does not decrease during the drying process, so it can be fed all year round (Franzel, Carsan, Lukuyu, Sinja & Wambugu, 2014). Feeding dairy cows 2 kilograms of dry Calliandra matter (or 6 kilograms of fresh matter) has a similar beneficial effect on the milk production as feeding them 2 kilograms of dairy meal as it contains approximately the same amount of digestible proteins (Place et al., 2009). Ideally, a lactating cow is fed 2 kilograms of dry matter each day. To provide this amount of Calliandra plant matter, 500 shrubs are needed to maintain one cow (Place et al., 2009). In an agroforestry system, 500 shrubs can be planted on 1.5 ha without replacing the present crops (Place et al., 2009). The field that is available for farming at the Kidiki school is 0,78 ha, giving the possibility to plant approximately 260 Calliandra shrubs. This will not be sufficient to meet the ideal amount of Calliandra matter for the two lactating cows. Despite this, we are convinced that also a lower amount of protein supplement will have significant positive effects on the milk production.

3.3.3. Impact of the lead

Feeding the lactating cows, the Calliandra plant matter will improve their protein uptake and help to meet the energy requirements to produce a higher amount of milk. In theory we can expect that feeding a cow 1 kg of dry Calliandra plant matter will lead to 0,8 kg of milk production on average (Place et al., 2009). This increased production will be used for consumption by the students and hence won't generate extra income for the school but will be important to lower the food cost and diversify the diet.

3.3.4. Conclusion lead

One of the next steps we will take in this lead is finding out where seeds can be bought as this is known to be a difficulty (Franzel et al., 2014). Further we will immerse ourselves in the cultivation process of the shrub so we can put words into action during the implementation phase. Additionally, we will discuss with the local partner whether there are also possibilities to buy more nutritious fodder at a low price and possibly add it to the diet.

3.4. Kidiki Kitchen

3.4.1. Initial lead

At the same time as realizing this expansion, in tandem with local actors, AFD students jointly guide the school towards optimal deployment and management of these resources, ways to maximize yield and minimize risks, and bring the output to the school and the market.

From the project proposal

The above quote from our partner's project proposal makes it clear that while the focus is on increasing the yield, minimizing risks is also an important aspect underlying the improvement of the school. The current situation consists of cooking on a woodfire with basic resources (for 300+ pupils and staff!), which is inefficient and poses serious health risks. Because of this less efficient kitchen structure, a lot of money is lost, which could be invested in other purposes.

3.4.2. Research and development lead

The previous AFD team was working on improving the kitchen facilities towards a more efficient and safe solution. They did some research on buying new and more efficient cooking stoves in order to free up some extra money, as the money could be used for other purposes. These new, environmentally friendly cooking stoves would also pose fewer risks to the health of the kitchen staff (and possibly even to the students).

Even though these ideas of the previous team are good ways to make the school financially self-sustainable and profitable, we decided as a team to focus this semester on the other aspects discussed above, namely irrigation, agroforestry, upscaling the agricultural activities, etc… Although the improvement of the kitchen is not our first priority, we do see its potential and consider it possible to elaborate on this aspect in the second semester.

3.4.3. Impact of the lead

As stated before, the two main reasons for improving the kitchen were saving costs and reducing health risks.

3.4.4. Conclusion lead

Since no research has been done on this topic, we cannot draw any conclusion yet.

Chapter 4. Future directions

Month	Activity	Comment
December	Research & partner calls	Elaborating on the leads

January	/	Exam period
February and March	• Research on kitchen aspect of the project • Specific water demand • Water demand solution • Market survey; expected revenue • Research on fruit tree suitability for agroforestry	
April and May	• Elaborating on bucket drip irrigation • Elaborating on kitchen aspect • research on fodder tree planting and knowing finances • May report	Amadeo has his exams in may
June	/	Exam period (except for Amadeo)
July and August	• Project implementation • Reporting and documentation	
September	Reflection report and future team aid	

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Annex I – General Background Reading

Project Okwagaanana: http://www.okwagaanana.be/

Annex II – Additional Graphs and Figures

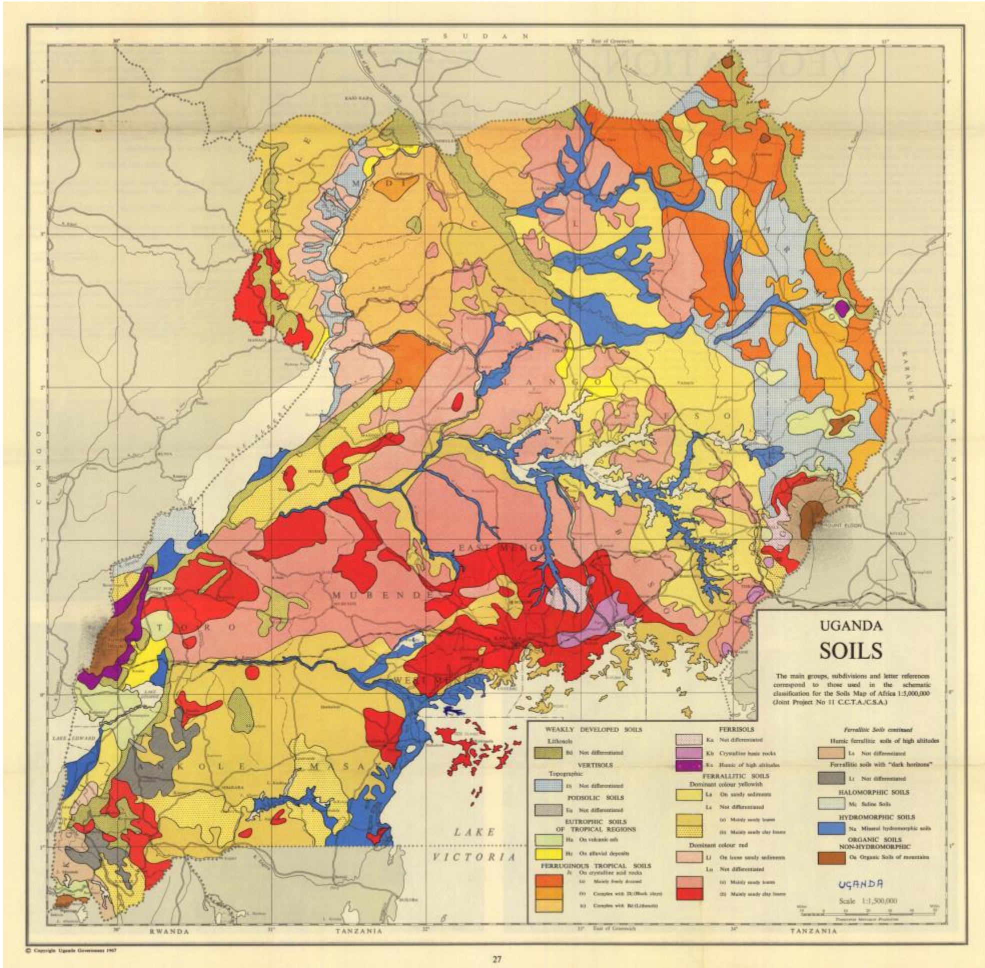

Figure 11. Ugandan soils. Retrieved from Ugandan Government, n.d. https://esdac.jrc.ec.europa.eu/content/uganda-soils. Copyright n.d., Esdac.

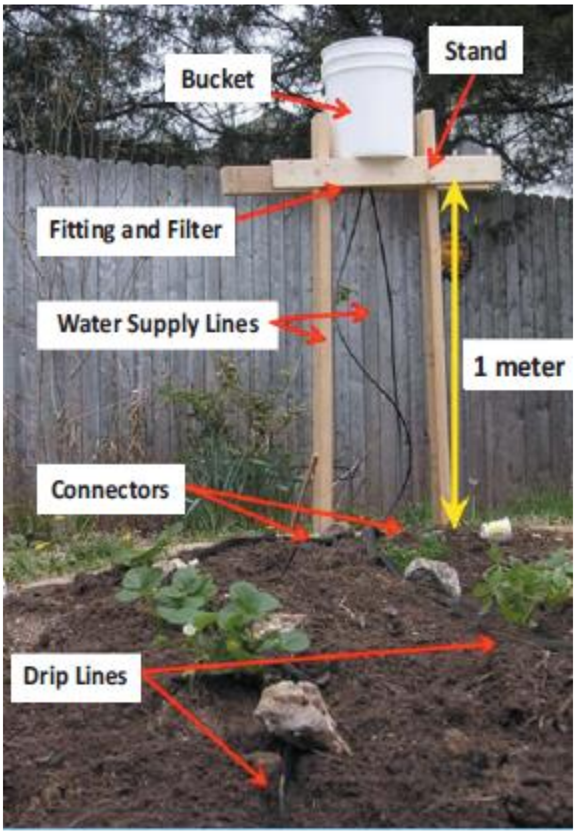

Figure 12. Installed bucket drip irrigation. Retrieved from Ugandan Government, 2016. http://www.pcrwr.gov.pk/Publications/Water%20Management/Drip%20Bucket%20Irrigation%20System%20for%20Small-Scale%20Agriculture.pdf. Copyright 2016, USDA & Icarda.

Frequency	Activity
Daily	• Evaluate recent weather (how hot, how dry, recent rain) • Fill drip buckets (typically twice a day) • Confirm that plants are getting adequate water • Inspect connections from the bucket to the drip lines • Inspect drip lines for holes and clogged emitters • If the day is going to be especially hot, consider adding shade cloth to protect delicate seedlings • If the weather may drop below freezing over the night, consider covering the seedlings
Weekly	• Inspect each plant for evidence of disease or inspect damage • Evaluate watering schedule. Consider adding more or less bucket fills per day • Remove weeds • Stir compost pile, add water if necessary • Add compost tea to leaf plants
Monthly	• Add compost tea to fruit plants • Begin a batch of compost tea every month • Consider flushing the drip tape irrigation lines

Figure 13. Maintenance tabel. Retrieved from Ashraf, 2016. http://www.pcrwr.gov.pk/Publications/Water%20Management/Drip%20Bucket%20Irrigation%20System%20for%20Small-Scale%20Agriculture.pdf.

Calculations document link

https://docs.google.com/spreadsheets/d/1b4h6VRRMmTwSGvH14qt-jYhHTszJgsT0hrVP3kzeKms/edit?usp=sharing