MODERN AGRICULTURAL FARMING METHODS AND SOIL MANAGEMENT TRAINING CONDUCTED AMONG NYUNGWE NZIZA'S AGRICULTURAL COOPERATIVES

FINAL REPORT

STRENGTHENING SUSTAINABLE ECOTOURISM IN AND AROUND NYUNGWE NATIONAL PARK (SSENNP)
"NYUNGWE NZIZA"

Program Title:	**Strengthening Sustainable Ecotourism in and around Nyungwe National Park**
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I. List of Acronyms and Abbreviations

DAI: Development Alternatives Inc.
USAID: United States Agency for International Development
KOTWIKI: Koperative Twiyubake Kitabi
DIC: Duhuzi Mbaraga Cooperative
N: Nitrogen
C: Carbon

II. Executive Summary

This report summarizes activities related to training, preparation and execution for two cooperatives working in the agricultural sector in Rwanda. Koperative Twiyubake Kitabi (KOTWIKI) Cooperative operates in Kitabi Sector, Nyamagabe District, Southern Province, and Duhuzi Mbaraga (DIC) Cooperative operates in Bushekeri Sector, District of Nyamasheke, Western Province.

Based on the value chain analysis carried out in 2012 by DAI's Value Chain Senior Specialist Alec Hansen , results revealed that, all of the hotels and lodges in NNP source the majority of fruits and vegetables from Kigali and even as far as Uganda. As a result, the prices of such commodities are high and there is considerable loss during transit. Discussions with these hoteliers during the course of our ecotourism value chain analysis indicated that they would prefer to source fruits and vegetables locally both as a means of reducing costs and increasing community income. However, quality and quantity of local produce is a key constraint.

In order to address this challenge, and during September 2012, Nyungwe Nziza released requests for proposals for fruit and vegetable production targeting agriculture cooperatives in Nyamasheke and Nyamagabe Districts, one of the few areas around the Park where soils and climate are good for agriculture. Six proposals were received and reviewed by the Rwanda Development Board, two agronomists from Kitabi and Bushekeri Sectors, hoteliers from around Nyungwe, and Nyungwe Nziza Project staff. Three proposals made competitive range and site visits were conducted. Based on the review committee's recommendations and site visits, two cooperatives were selected for support; Duhuze Imbaraga Cooperative (DIC) in Bushekeri and Twiyubake Kitabi Cooperative in Kitabi.

Nyungwe Nziza engaged a professional soil scientist, Dr. Naramabuye Francois, with the objective of strengthening farming activities carried out by Duhuze Imbaraga Cooperative (DIC) members in Bushekeri Sector, Nyamasheke Districti, and Koperative Twiyubake Kitabi (KOTWIKI) in Nyamagabe, by establishing a strategic environment enabling for both cooperatives to adopt a professional farming system for the production of high quality fruits and vegetables to supply hotels, restaurants and guest houses operating around Nyungwe National Park, as well as the local community. Ultimately, increased agricultural production will translate into improved household incomes among communities adjacent to Nyungwe National Park, hence contributing to the reduction of induced threats to wildlife conservation.

Duhuze Imbaraga Cooperative was created in 2008 and currently has 35 members of whom 27 are women. They have received land allocation from local government of two separate plots of land (about one hectare each). They are growing carrots, cabbage, onions, green beans, pineapples as field crops and mushrooms in a thatched shed. Koperative Twiyubake Kitabi was founded in 2012 and currently has 30 members, 27 of whom are women (former sex workers). They have been allocated 2 hacters of land by local government (a two-year lease) and are

growing carrots, cabbages, green beans, peas and potatoes to sell to local hotels. All members of these two cooperatives participated in the training.

It is expected that the DIC Cooperative and the KOTWIKI Cooperative will serve as positive examples and provide assistance and guidance to other cooperatives operating in Districts of Nyamagabe and Nyamasheke

A participatory approach of training was used and the teaching materials were translated in Kinyarwanda to ensure a better communication between the trainer and the trainees. The training covered the following subjects/activities for the two cooperatives:

- general principles of agriculture and soil fertility
- techniques to prepare organic fertilizers
- soil acidity management using travertine and lime
- visit to travertine mining site at Mashyuza

Additionally, the following subjects were also covered:

- training for DIC Cooperative farmers on techniques of mushroom production
- training for the sector agronomist in best practices for aiding local cooperatives with the implementation of the lessons learned in their respective instructional sessions.

The training objective was to provide very basic knowledge on agriculture and soil fertility management so that the beneficiaries would use this knowledge to increase crop productivity.

1. Background and Introduction

The USAID-funded Strengthening Sustainable Ecotourism in and around Nyungwe National Park Project (SSENNP), otherwise known as Nyungwe Nziza or beautiful Nyungwe, is working to transform Nyungwe National Park (NNP) into a viable ecotourism destination, capable of generating employment and sustainable and equitable income for local communities and other stakeholders, thus providing economic incentives to conserve the rich biodiversity of the Park. The ultimate goal is to achieve a thriving economy in NNP with engaged communities and a private sector, that which would realize that these communities could benefit economically by protecting and leveraging the unique environment in which they live and work.

Communities around the Park are generally recognized as the perpetrators of many illegal activities in the Park, from mining, poaching and traditional bee keeping to firewood and bamboo harvesting. Thus, under the Small Grants Fund (SGF), Nyungwe Nziza's objective is to expand and develop sustainable value chain community enterprise initiatives, in order to increase household incomes of local communities, and ultimately serve as an incentive to conserve Nyungwe National Park's rich biodiversity.

In September 2012, Nyungwe Nziza released requests for proposals for fruit and vegetable production targeting agriculture cooperatives in Nyamasheke and Nyamagabe Districts, one of the few areas around the Park where soils and climate are good for agriculture. Six proposals were received and reviewed by the Rwanda Development Board, two agronomists from Kitabi and Bushekeri Sectors, hoteliers from around Nyungwe, and Nyungwe Nziza Project staff. Three proposals made competitive range and site visits were conducted. Based on the review committee's recommendations and site visits, two cooperatives were selected for support; Duhuze Imbaraga Cooperative (DIC) in Bushekeri and Twiyubake Kitabi Cooperative in Kitabi.

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2. Methodology

The participants were divided into two groups based on their responsibilities within their respective cooperatives and their previous level of training. The first group contained the sector agronomist, the cooperative's executive committee and those individual who had prior knowledge of agricultural and soil management. The separation of this group of individuals from those less educated allowed the trainers to cover more in-depth and advanced material. This group benefited from two days of training. The goal for the first day of training was twofold. Firstly, intensive instruction was given on the basics of agriculture, which included soil management, use of fertilizers, composting, appropriate crop rotations, etc. Secondly, instructors ensured that all trainees were confident in their understanding and knowledge of agriculture and soil fertility, thus allowing them to lead group assignments the following day.

The second group of trainees was comprised of all other members of the cooperatives. Given the relatively low education level of the members. Videos and power point presentations were used to facilitate farmers understanding.

3. Teaching Units

During this training three different topics of instruction were introduced

- soil nutrients and composting
- soil fertility and soil acidity management using lime/travertine
- mushroom production

These topics are discussed below with additional information contained in referenced Appendixes 1 and 2. Appendix 1 is similar information, however, it was translated into Kinyarwanda to ensure understanding by all the participants.

3.1 Soil Nutrients and Composting

Instructors began this session by explaining to the trainees the overwhelming evidence in support of composting. It was explained that composting is a simple and highly effective method of ameliorating the soil. The improved soil quality will in turn increase crop yields and profit for the farmer with little to no additional cost.

3.1.1 Concepts of Soil Nutrients

The trainer began by explaining the origin of nutrients in soils and the dynamics involved in various nutrient cycling. The process of nutrient uptake by plant roots was also discussed. This allowed a better understanding of nutrient mining by plants and the progressive soil infertility due to over cultivation. This discussion also provided a logical segue to our unit on composting.

3.1.2 Concepts of Composting

Composting is an aerobic process by which organic materials are degraded through the activities of successive groups of microorganisms; it is an environmentally sound way to reduce organic wastes and produce organic fertilizers or soil conditioners (Gajdos, 1992 L.). Based on the definition above and on our own experiences, it is proposed that composting is defined as the process of changing organic materials into agricultural soil amendments. Temperature, moisture, appropriate aeration as well as a general knowledge of Carbon-Nitrogen ratios (C:N) in various organic materials all play vital roles in the decomposition of organic matter.

3.1.3 Principles of Composting

The process of composting is primarily carried out by microorganisms. These microorganisms require for their growth and reproduction, a supply of food containing carbon and nitrogen (FAO, 2002). In nature, the organic matter (waste) is broken up by a series of biological and chemical process involving these biological agents. Heaps of compost provide microorganisms such as microscopic greens, insects, bacteria, mushrooms and others a food supply to aid in this growth and reproduction. These organisms also chew this waste which is then further transformed by redox and hydrolysis reactions. These reactions require aeration, which simply put is a turning of the soil. This allows oxygen to reach the aerobic bacteria which are highly effective in breaking down organic waste. This decomposition process also produces high intensity heat. The temperature may reach between 50° Celsius and 70° Celsius (Maniraguha, 2001). This rise in temperature partly eliminates the seeds of weeds, viruses, pathogenic bacteria and nematodes (Rebollido, 2008). The variation in the temperature influences the variations of the micro-organisms species of the heap in composting. (Maniraguha, 2001).

3.2 Soil Fertility and Soil Acidity Management Using Lime/Travertine

This training unit was designed to bring famers and the sector agronomist a better understanding of how soil nutrients are mined from the soil by crops and how this may be remediated to allow a continuous crop growth. This unit was scheduled as following:

- General guidelines
- Soil acidity sources
- Soil acidity correction
- Calculation of quantity of Mashyuza travertine needed
- Application of travertine and cooked lime.

The farmers were also taken to the Mashyuza mining site to gain a first-hand look at the different techniques for cropping vegetables. They were given the opportunity to visit the travertine mining site of Mashyuza as well as witness the travertine processing procedures. It was clearly explained to beneficiaries how better travertine can be used in acidic soils and how to estimate the amount to be applied. For more detailed information, please refer to Appendix 3. This handout was provided to the sector agronomists.

3.3. Training on Mushroom Production

As detailed in the Appendix 4, farmers from the DIC cooperative as well as the Sector agronomist were trained on how to produce mushrooms. Simplified scientific explanations were given to allow the farmers to better understand the methods of propagating this new agricultural product. The training was concentrated on the following subjects:

- The role of mushrooms in human nutrition
- Preparing the mushroom greenhouse
- Soil preparation and irrigation
- How to prepare and plant mushroom seeds
- Follow-up measures to ensure successful growth
- Disease protection
- Harvesting and proper storage techniques
- Mushroom varieties

The topics above were discussed in great detail and a handout was provided to the students. At the end of the teaching session, practical exercises were executed by the farmers to ensure that they had a solid understanding of the subject matter. Farmers were able to repeat information

given to them about mushroom production to the trainers in Kinyarwanda. This assessment showed that farmers received enough information and hands on training to undertake a mushroom production project independently.

4. Conclusion

At the end of each training unit an assessment was conducted together with the DAI technical staff and field coordinators to test the level of understanding of farmers. The method used for testing the knowledge was adapted to the level of education. Poems and songs were applied to allow everybody to express himself/herself freely. Most of the farmers had acquired knowledge related to major soil nutrients and the proper methods to return the soil to optimum production. The farmers were able to explain in Kinyarwanda how materials used for compost preparation are prepared and how the compost process occurs. They were given the opportunity to visit the travertine mining site of Mashyuza as well as witness the travertine processing procedures. All beneficiaries enjoyed this site visit and gained practical knowledge. It was clearly explained to beneficiaries how better travertine can be used in acidic soils and how to estimate the amount to be applied.

5. APPENDIXES

APPENDIX 1:

HANDOUT FOR FARMERS ON COMPOST TRAINING (KINYARWANDA)

Koperative Kotwiki, Intara Y'amajyepfo

Akarere Ka Nyamagabe

Imashanyigisho Ignenewe Abanyamuryango Ba Kotwiki Gutunganya Ifumbire

Y'Imborera

Iyi mfashanyigisho yatewe inkunga na USAID ihagarariwe na DAI.

Byakozwe na Prof. Naramabuye Francois-X afatanije na Sirikare N. Sylvere

KAMINUZA Y"URWANDA

May 2014

Intangiriro

Iyi mfashanyigisho yateguwe na Prof Naramabuye Francois-X, umwarimu akaba n'umushakashatsi muri Kaminuza y'uRwanda, afatanije na SiUA. Aba bashakashatsi bombi bakora kubyerekeye ubumenyi n'uburumbuke bw'ubutaka

I ki gikorwa cyatewe inkunga na USAID ibinyujije mu mushinga wa DAI ukorera ku nkengero z'ishyamba rya Nyungwe. Uwo mushinga ugamije guteza imbere ubukyerarugendo muri Nyungwe ukanatera inkunga abaturagye baturiye Nyungwe mu mishinga itandukanye. Amwe mu ma Koperative aterwa inkunga na DAI harimo Koperative Twiyubake ya Kitabi ikorera mu Murenge wa Kitabi, Akarere ka Nyamagabe, Intara y'amajyepfo. Indi koperative iterwa inkunga na DAI ni Koperative Duhuze Imbaraga (DIC) ikorera mu Murenge wa Bushekeri mu karere ka Nyamasheke Intara y'Uburengerazuba.

Iyi mfasha nyigisho rero izafasha abagize izo koperative zombie kwongera ubumenyi mu bijyanye n'uburyo bwiza bwo gukora ifumbire y'imborera, kuyibika no kuyikoresha mu mirima.

Ifumbire bazakora izabafasha gufumbira imboga bazajya bahinga hanyuma bazigurishe mu mahoteri aturiye Nyungwe.

Iyi fishi iratanga mu magambo ahinye intambwe zikurikizwa kugira ngo hakorwe ifumbire y'imborera ifite ireme. Abazakoresha ibikubiye muri iyi fishi base nkuko biteganijwe bazagera kw'ifumnire y'imborera ifite ireme.

1. Ifumbire y'imborera isbanuye iki?

Ifumbire y'imborera ni ifumbire ikorwa hakoreshejwe ibishingwe bibora, byaba ibituruka ku matungo cyangwa ibihingwa. Kugirango iyo fumbire iboneke ibyo bishingwe biraboreshwa igihe gishobora kuba kigufi cyangwa kirekire biturutse ku miterere y'ibyo bishingwe n'uburyo bwakoreshejwe mu kubiboresha.

2. Ifumbire y'Imborera ikorwa ite?

2.1.Aho ifumbire ikorerwa haba hameze hate?

Hari uburyo bwinshi bwo gutunganya aho ifumbire ikorerwa. Uyikora ahitamo uburyo akoresha akurikije amikoro ye. Hari uburyo mvaruganda n'uburyo bucirirritse. Hakurikijwe amikoro ya koperative zimeze nka koperative KOTWIKI na DIC, uburyo bugiye gusobanurwa hepfo ni uburyo bucirirritse bwo gukora ifumbire. Hashakwa ikibanza kingana hagatiya 2500 metero kare (1/2 cy'ikibuga cy'umupira w'amaguru) na 1250 metero kare. Hagomba kuba hadatemba, kandi hashije nk'ikibanza cy'inzu. Igice kinga nibura na metero kare 750 gikwiriye kuba gisakaje amabati cyangwa shitingi cyangwa ibyatsi bitava cyane. Hakwiriye kuba hari amazi akoreshwa mukuvomera ikirundo cy'ibishingwe iyo bibaye ngombwa. Hakwiriye kuba hari ibiti n'imbaho byo kubakira ikirundo. Hakwiriyekuba hari ibikoresho byo kuyora no kwegeranya cyangwa gusanza ibishingwe (Ibitiyo, amasuka, umupanga,...)

2.2.Gushaka ibishingwe

Igikorwa kibanza ni ukwegeranya ibishingwe no kubivangura. Icyo gikorwa gifite akamaro cyane kubera ko iyo gikozwe neza bituma ifumbire igira agaciro n'ubuziranenge bwo murwego rwo hejuru, nanone byakorwa mu buryo budatunganye bigatuma ifumbire itakaza agaciro kayo. Ibishingwe byegeranywa hibandwa ko nta bishingwe bitabora byivangamo (amabuye, ibyuma, amasashe, ibintu bya plastike, ibirahure, amabuye ya bateri, umucanga n'ibindi...). Biba byiza iyo byegeranijwe bitaratangira kubora. Ni byiza gushaka ibishingwe by'ubwoko bunyuranye kugirango ifumbire izabe ifite imyunyu (Kalisiyumu, Manyeziyumu, Potasiyumu, Sodiyumu, umuringa, Silisiyumu, Kobaliti, n'ibindi) n'izindi ntungabihingwa (Azoti, Fosiforo, Sulufuri, Kariboni, ...) zikenewe kugirango igihingwa gikure kandi cyere neza. Imvange y'ibishingwe igizwe n'imyavu yo mu rugo igizwe n'ibishishwa by'ibitoke,

ibishishwa by'ibirayi, ibyibijumba, ibisigazwa by'imboga, ibiryo bisigara bijuguhywa, ibisigara nyuma yo gutunganya inyama cyangwa anafi, ibishishwa by'ibishimbo, amashaza, cyangwa soya. Ibi bivuzwe haruguru byiganjemo azote n'imyunyu. Iyo hakoreshejwe amase y'amatungo biba byiza kurusha kubera ko akungahaye kuri azoti. Nibyiza ko bivangwa n'ibishingwe byiganjemo Karibone kugirango udukoko duhindura ibishingwe mw'ifumbire tubone imbaraga zo gukora umurimo watwo. Iyo ibishingwe byiganjemo Azote ari bikyeya ugyereranije na Karibone, ibishingwe bitinda kubora kubera ko udukoko duhindura ibishingwe mo ifumbire dutinda kororoka kubera Azoti idahagije. Naho iyo ibishingwe byiganjemo Azoti nyinshi ugereranije na Kariboni (hasi ya 25=C/N) , ibishingwe birihuta kubora kubera ko udukoko twororoka vuba cyane Bityo tugakora umurimo watwo vubavuba.

2.3. Kuboresha ibishingwe

Bimaze kugezwa aho ifumbire ikorerwa, hakurikiraho kubishyira mu kibanza cyabugenewe bikavangwa neza kurugero nkuko byasobanuwe haruguru. Hongerwamo amazi makeya hanyuma bikaguma aho. Udukoko dukora umurimo wo guhindura ibishingwe mo ifumbire dukeneye nanone amazi, ubushyuhe n'umwuka (Ogisijene) biri mu rugero rwiza kugira ngo dukore neza. Ni ngombwa rero ko ibishingwe bigenda bigaranzurwa buri gihe kugira ngo umwuka winjire, ubushuhe ntibuzamuke bikabije kandi hongerwemo amazi ku rugero.

Uko igihe kigenda ni nako ibara ry'ikirundo rigenda rihinduka, riva kw'ibara ry'icyatsi riba umuhondo uteruye, riba umuhondo uhiye, riba ikijuju kugeza igihe ribereye umukara tsiritsiri. Uko ibara rigenda rihinduka, ni nako uduce tugize ikirundo tugenda tuba dutoduto kugeza igihe udashobora kumenya ubwoko bw'ibishingwe byabyaye ifumbire. Uko iminsi igenda, ni nako ubushyuhe bugenda bwiyongera mu kirundo hanyuma bukagera igihe bugenda bugabanuka kugeza igihe ifumbire iba ihiye. Iyo ibyo byose bivuzwe haruguru byarangiye kuba tuvugako imfumbire yahiye

Bitewe n'ikigamijwe, ifumbire ishobora gukoreshwa igihe cyose itarashya. Iyo ubutaka bufite imyunyu na Azote, Fosifori ariko ibuze Kariboni, ifumbire ishobora gukoreshwa Itarashya, igifite kariboni nyinshi. Impamvu itera iyo mikoreshereze ishobora kuba kongerera ubutaka ubushobozi bwo kubika amazi cyangwa indi mpamvu. Ubundi ifumbire y'imborera ishobora no gukoreshwa igitose ariko itarashya neza. Icyo gihe ishobora gutanga ibikenewe ngo igihingwa gikure ariko bitari byose, ibyo bikorwa bitewe n'ubwoko bw'igihingwa gikyeneye ko imyunyu n'ibindi bikenewe bigenda bikigeraho uko kigenda gyikura. Biturutse ku miterere y'ubutaka cyane uburimo umucanga mwinshi, imyunyu iyo ibonekeye rimwe ari myinshi ishobora kujyanwa n'amazi uko igihingwa kigenda gikura kikayibura.

Ubundi rero muri rusangi, ikyigenderewe mu gukora ifumbire y'imborera ni uguhindura ikinyabuzima kikavamo ibikenewe kugirango igihingwa gyikure kandi gitange imbuto nziza.Ibyo kugirango bishoke ni uko ifumbire ishya noneho igakoreshwa nk'indi nyongera musaruro yose., igakoreshwa nk'ifumbire mvaruganda.

3. Ibyo ukora ifumbire agomba kwirinda

- Kutavangura neza ibishingwe hakaba hagumamo amabuye, imicanga, ibyuma, plastike, amasashe, amabuye ya radiyon'ibindi bintu byose bitabora kubera impamvu zavuzwe haruguru.

- Kunyagiza ikirundo cy'ibishingwe, bituma ubushuhe mu kirundo bugabanuka bityo udukoko tukaba twakwicwa n'imbeho cyangwa tukicwa no kubura umwuka kuko ahagiye amazi hava umwuka wa Oxigeni. Iyo ubuzima bw'udukoko buhungabanye, umusaruro w'imirimo dushinzwe uragabanuka bityo ibishingwe ntibibore neza. Iyo ibishingwe bimazekubora azote iba igaragara cyane nka Nitrate. Imvura rero ifite ubushobozi bwo gutwara Nitrate hanze bityo ireme ry'ifumbire muri azote rikagabanuka cyangwa ifumbire yose igatakaza ireme..

- Gutinda kubika ifumbire ihiye. Nanone Azote ishobora kugaragara nka Amoniyamu.Iyo ifumbire itabitse neza cyangwa se idatwikiriye, amoniyamu iratumuka ikajya mu kirere ikaba yakwangiza, ibyo ibidukikije. Iyo amoniyamu ivuye mw'ifumbire nanone ifumbire itakaza ireme ryayo .

APPENDIX 2:

TRAINING HANDOUTS FOR KITABI AND BUSHEKERI

USAID/Nyungwe Nziza Project

Supporting Farmers Cooperatives Working in the Nyungwe Area (KOTWIKI and DIC)

Composting Techniques

By Prof. Naramabuye Francois-X and Sirikare Sylvere (PhD)

May 2014

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1. Introduction

1.1 Concepts on composting

A number of scientists had defined composting following personnal research experiences as following: composting is defined as a process of aerobic thermophilic microbial degradation or an exothermic biological oxidation of various wastes by many populations of the indigenous microorganisms which lead to a stabilized, mature, deodorized, hygienic product, free of pathogens and plant seeds, rich in humic substances, easy to store and marketable as organic amendment or fertilizer (Gbolabo. A *et al*, 2009). Composting is an aerobic process by which organic materials are degraded through the activities of successive groups of microorganisms; it is an environmentally sound way to reduce organic wastes and produce organic fertilizer or soil conditioner (Gajdos, 1992 L.). Composting is a controlled microbial aerobic decomposition process with the formation of stabilized organic materials that may be used as soil conditioners and/or organic fertilizers (Ndegwa. P *et al*, 2001;). Other authors including Gajdos .R, 1992; Heckman.J, 2006).

Based on the above approaches of definition and on our own experience, it proposed that composting is defined as the process of changing organic materials into agricultural soil amendments where temperature, moisture, C/N ration of raw matrials is determined prior to the

composting process. It is important to note that the process is mainly carried out by macro organisms and microorganisms. The microorganisms require for their growth and reproduction, a supply of food containing carbon to provide energy and material for new cell and nitrogen for cell protein that are provided by these organic materials (FAO, 2002). Several techniques are involved in composting like heap preparation, turning the composting heap, preparation, irrigation, and harvesting of final product as proposed by a number of researchers including Smith.R.C, 1995 and Maniraguha, 2001.

1.2 Composting principles

In nature, the organic matter (waste) is breaken up by a series of biological and chemical process involving biological agents. The microscopic greens, insects, bacteria, mushrooms and other micro-organisms chew this waste which is more and more transformed by hydrolysis and redox reactions. (Maniraguha, 2001)

The reaction which results from it, require aeration. This process of decomposition produces much heat; the temperature reach 50 to 70^{o} C and then decreases. This rise in the temperature partly eliminates the seeds of weeds, viruses, pathogenic bacteria and nematodes. (Rebollido, 2008). The variation in the temperature influences the variations of the micro-organisms species of the heap in composting. Bacteria are always present in a heap from the beginning of the process until maturation of the product. (Maniraguha, 2001,)

1.2.1 Organisms involved in composting

The most active organisms that are involved in composting are classified in two categories:

1.2.1.1 Micro-organisms:

i.Bacteria

They have sizes and variable forms (often filamentous). They are always present in the mass of organic waste from the very start of the process. They remain active during all composting and in particular at high temperature. They multiply very quickly. This fast multiplication and in great number of different species allows the use of organic residues "all coming".

ii. The fungi

They act especially on the matters which resist the bacteria. They have a capital role. The mushrooms do not resist temperatures higher than 50 °C; what explains why one more particularly finds them in periphery of the compost.

iii. The actinomycetes

They are kinds of filamentous bacteria; they act more tardily than these bacteria and the mushrooms and multiply less quickly. The actinomycetes are active in the last stages of composting. They specialized in order to tack the more resistant structures like cellulose, hemicelluloses and lignin (components of wood in particular). Concurrently to these three types of micro-organisms, one also finds in the compost, of the algae, the viruses, of the protozoa...

1.2.1.2 The macro-organizations (Earth worms and termites).

The macro organizations are much diversified in the process of composting. The lombrics of the compost, for example, act at the beginning of the process, on little broken up elements (after the thermophilous phase). They integrate a mixture of organic remains thus and their excrements constitute an ideal medium for the microbiological activities of the ground which lead to the development of the ripe compost. Many of other macro organizations appear, especially in the phase of maturation of the compost. The principal macro organizations of the compost are the worms of compost or manure (several kinds), the insects, the acarina, the gastropods, the myriapodes, the woodlice, etc…

Table 1 Mature compost properties

Nutrients	Mature compost
Nitrogen (N) (%)	1-4.5
Corbon (C) (%)	13-22
Potassium (K) (mg/kg)	5000-29000
Phosphorus (P tot) (mg/kg)	8000- 10000
Calcium (Ca) (mg/kg)	20000-30000
Magnesium (Mg) (mg/kg)	3000- 19000

Table 2 Extractable micronutrients

Micronutrient	**Standard**
Manganese (Mn) (mg/kg)	500
Zinc (Zn) (mg/kg)	400-2800
Cooper (Cu) (mg/kg)	100-1500
Iron (Fe) (mg/kg)	100-21000

APPENDIX 3:

HANDOUT FOR BUSHEKERI AND KITABI SECTOR AGRONOMIST USAID/DAI

Training of KOTWIKI and DIC

Training 2: Soil Management

Sector Agronomists (Bushekeri and Kitabi)

by Prof. Naramabuye Francois-X and Sirikare Sylvere (PhD)

June 2014

Soil Fertility Management Recommendation

Guidelines

- The methodology adopted to compute the fertilizer recommendation was based on the comparison of the actual soil fertility status and the general crop requirements in terms of soil major nutrients (Nitrogen, Phosphorus and Potassium…) and soil condition (soil acidity status, soil organic Carbon content, electrical conductivity, soil texture class…). Based on the results from laboratory analysis and field observation, it is clear that any agricultural activity would necessarily require liming and organic matter application.

- Indeed, the soils from the 5 sites were acidic (pH (water) ranging from 3.6 to 4.4). All the soils will need to be limed to achieve a soil pH between 6 and 6.5 to allow availability of a number of nutrients needed for a good crop development. However, given the fact that DAI does not allow the use of chemical fertilizers, Nitrogen, Phosphorus and Potassium needs will be translated into organic amendments (animal manure or compost) and the recommendations will be calculated in terms of tons of organic amendments.

- Amendments recommendations were calculated on the basis of nutrients needs of crops proposed to be established as well as the present available soil nutrient concentration provided above. At this stage, it is important to note that whatever crop proposed, there are minimum requirement levels in soil organic matter content, and soil pH value to allow a good availability of soil nutrients, water holding capacity, soil microbial activity and plant nutrition.

- It is understood that a good fertilizer recommendation and soil management shall be developed on the basis of specific characteristics including the type of crop to be established. The proposed crops include fruit (pineapple and Japanese prunes) and vegetables (carrots, onions, peas and green beans).

APPENDIX 4:

MUSHROOM TRAINING HANDOUTS IN KINYARWANDA

USAID/Nyungwe Nziza ProjectTraining for DIC

Amahugurwa Kuburyo Bwo Guhinga Ibihumyo Agenewe Abagize Cooperative

Byateguwe na Prof. Naramabuye Francois-X (Kaminuza y'uRwanda)

hamwe na Akimana Bertrand (Field Technician)

September 2014

IBIRIMO

- **IRIBURIRO 1**

Ubuhinzi bw'ibihumyo ni bumwe mu buryo bufasha abahinzi kurya neza no kwivana mu bukene kandi bidasabye isambu nini. Aka gatabo kanditswe na Prof Naramabuye F-X (Kaminuza y'uRwanda) hamwe na Akimana Bertrand (Field Technician kagamije kwereka abahinzi b'ibihumyo n'abandi bashaka kujya muri uyu mushinga uburyo bworoshye bwo guhinga ibihumyo ndetse no kubishoramo imari.

- Iriburiro 2

Ibihumyo bivugwa muri aka gatabo ni ibyo mu bwoko bwa *Pleurotus ostreatus*, bukaba bumwe mu bwoko bw'ibihumyo biribwa kandi bihingwa mu butaka.

Aka gatabo gasobanura uburyo bworoshye kandi bunononsoye bwo guhinga ibyo bihumyo mu butaka, kakagaragaza akamaro ntungamubiri k'ibyo biribwa, kakerekana kandi n'umusaruro mpuzandengo w'ubuhinzi bwabyo.

- Iriburiro 3

Amakuru ari muri aka gatabo agabanyijemo ibice 4 by'ingenzi:

Amakuru rusange ku bihumyo,

Ihingwa ry'ibihumyo bya "*Pleurotus ostreatus"*

Isarurwa ry'ibihumyo bya "*Pleurotus ostreatus"*

Gushora imali mu buhinzi bw'ibihumyo bya "*Pleurotus ostreatus"*

Iri zina ni mvamahanga, hamwe na hamwe bakunze kubyita "Pelerote" ariko ahenshi ntibirabonerwa izina ry'ikinyarwanda

- **2.Ibihumyo ni bihingwa ki?**

Igihumyo ni igihingwa cyihariye; ntikigira indabo cyangwa imbuto.Kigizwe n'ibice bitatu by ingenzi: Umurundugushyu, Umuringa n'ingofero.

Umurundugushu wacyo ntugira imizi, amashami n'amababi. Ibi bisimburwa n'**umuringa** ndetse n'**ingofero**. Uyu murundugushu niwo ufata ku **mugina** aho giteye ukavomamo intungamubiri.

- **3.Ibihumyo bimaze iki mu mirire y'umuntu?**

Mu ntungamubiri zigize ibihumyo harimo izituma ubiriye

- Yirinda indwara z'imirire mibi,
- Yirinda indwara zijyanye no kugira amaraso make,
- Igifu, umwijima n'amara bye bikora neza;
- Bimufasha kwituma neza,
- Yongerera umubiri ubushobozi mu kwirwanaho,
- Yirinda indwara ziterwa no kugira ibinure byinshi mu miyoboro y'amaraso,

- Agira amagufa akura neza kandi akomeye,
- Agira umubiri utoshye kandi utarwaragurika

Ibihumyo bifasha izindi ntungagihingwa gukora neza akazi kazo.

- 4.Ubwoko bukunze guhingwa ***Pleurotus Ostreatus***
- Buhingwa mu butaka,
- Buroroshye guhinga,
- Ntibusaba ikoranabuhanga rihambaye,
- Ntibusaba ubutaka bunini kuko no kuri metero kare imwe hahingwa (Intambwe imwe ku yindi)
- Ibikoresho bikenerwa mu kubuhinga biboneka hose mu Rwanda ku buryo bworoshye,
- Umusaruro wabyo urashamishije: ku mugina umwe hashobora kweraho hagati g 600 na kg 1,
- Ibihumyo byerera igihe gito cyane: hagati y'iminsi 7-10 uba utangiye gusarura,kandi ukamara amezi 3-4 usarura,
- Gutangira kubihinga ntibisaba amafaranga menshi, umuntu ashobora guhera ku mafaranga 50,000 gusa,
- Ntibitwara umwanya munini mu kubyitaho, bityo rero **ubihinze arunguka.**
- **Amoko y'ibihumyo bihingwa mu Rwanda5.**

Mu Rwanda hamaze kugera amoko menshi y'ibihumyo. Amwe yatangiye guhingwa andi aracyari mu bushakashatsi:

Muri aya moko yose pleurotus ostreatus niyo yatangiye guhingwa, andi aracyari mu bushakashatsi

- **6.Uburyo ibihumyo bihingwa**

Umuhinzi ushaka guhinga ibuhumyo agomba kuba afite **imigina** (imbuto) kandi akubaka **igisharagati** (umurima).

6.1 Umugina w'ibihumyo

Umugina ni uruvange rw'**ibyatsi** biseye babibamo **umwayi**

w'ibihumyo bikamara iminsi 40 kugeza kuri 45 bibitse ahantu

habugenewe kugirango ube ugeze igihe cyo guhingwa.

- **6.Uburyo ibihumyo bihingwa**

Mu gukora umugina hifashishwa **ibyatsi** birimo urubingo, ibigorigori, ibitiritiri, ibishogoshogo by'ingano, iby'umuceri, iby'uburo, iby'ibishyimbo, ibikatsi n'ibikongorwa by'ibisheke n'ibikenyeri by'amasaka. Hifashishwa kandi **ifumbire mvaruganda (Urea); Ishwagara** n'**imashini** eshatu harimo isya ibikoresho byavuzwe haruguru, ibivanga ndetse n'ishyira imvange mu mashini

Mbere yo kugura umugina,ni ngombwa kugenzura niba ari mwiza. Umugina mwiza ni uwera (wuzuye), wererana udafite uburwayi cyangwa indi nenge .

Uburwayi ku mugina bugaragazwa n'ibara ry'icyatsi cyangwa se

iry'umukara

Umugina ufite aya mabara umuhinzi akwiye kuwirinda kuko unawuteye utakwera ibihumyo.

- **6.2 Akazu gahingwamo ibihumyo**

Mu rwego rwo kwirinda icyabangamira gukura neza kw'ibihumyo, ni byiza kubaka igisharagati.

- Kure y'**ikiraro** icyo aricyo cyose,
- Kure y'**umusarani**,
- Kure y'**ububiko** n'ibikoresho by'**imiti**,
- Kure y'**ikidendezi cy'amazi** na
- Kure y'**ikigega cy'imyaka**;

Ukanamenya ko mu gisharagati hagomba guhora **hahehereye**.

Mu kubaka igisharagati si ngombwa gukoresha ibikoresho bikomeye cyane cyangwa se bihenze. Igikenewe ni ubuhehere, umuka n'urumuri biringaniye. Cyakora ni byiza ko igisharagati kiba kitava kugira ngo ibihumyo bitangirika mu gihe cy 'imvura. Igisharagati gishobora kuba mpandeshatu cyangwa se mpandenye.

6.3 Uko akazu gahingwamo ibihumyo kaba kangana

Uburebure= 10 m

- **Ubugari=8m**
  Ubuhagarike: aharehare=3.5m, ahamena amazi=2.5m

- **6.4 Gutegura aho umugina uterwa**

Iyo umaze kubaka igisharagati, ucukuramo uturingoti cyangwa imitabo. Dukurikije ibipimo by'igisharagati cyatanzwe haruguru, umutabo umwe ugira metero 4 kuri m 0.8 (cm 80) n'ubujyakuzimu bufite hagati ya cm 25 na cm 30. Imitabo yose hamwe ni 10 iciye ku buryo hasigara inzira ya metero imwe hagati mu gisharagati.

- **6.4 Umugina uterwa ute**

Ku bugari n'uburebure bingana n'intambwe 1 ku yindi ($1m^2$) iri mu gisharagati, haterwa imigina 64

- Mu turere dukonja nko mu majyaruguru hagaragaye umusaruro utubutse kurusha ahandi ku buryo batera imigina 32 gusa kuri m^2 imwe kugira ngo ibihumyo bitabangamirana,

- **6.4 Umugina uterwa ute**

- Utera imigina, ayitereka ku murongo ayitondekanya muri wa mutabo, yegeranya umwe ku wundi, yarangiza akorosaho agataka ka cm 1 (kangana n'umubyimba w'urutoki)

- **6.5 Kuvomerera umugina**

- Iyo bamaze gutera imigina baravomerera na mazi.
- Muri rusange umugina umwe uvomererwa n'amazi angana n'ayajya mu icupa rya fanta (ml 300) ariko igipimo cya nyacyo giterwa n'ubuhehere bw'ubutaka buhinzemo.
- Iyo umaze kuvomerera, ushyiraho ishashi igondeye ku biti byibura kuri metero 1 ubariye aho igiti kigondeye, kugira ngo hagumaho ubuhehere kandi hatagira ikibazo cyo kumagara kugeza igihe bitangiye kuzamuka.

6.6 Kurwanya umuswa

- Ushobora gushyira ivu cyangwa ishwagara mu mutabo mbere yo gutera imigina,

- Ugatera imigina wayipfumuye munsi no hejuru gusa ishashi ukayirekeraho,
- Kandi ugasiga ibiti byubatse igisharagati cyawe godoro cyangwa vidange kugirango ubirinde gufatwa n'umuswa cyangwa se kumungwa.
- 6.6 Kurwanya umuswa
- Ushobora ndetse gusasa hasi mu mutabo ishashi y'umweru yo mu bwoko bw'iyoroswa ku mugina kugirango ifashe gukingira imigina kwangizwa n'imiswa.
- Ariko mu gihe bigushobokeye, wakwirinda gutera imigina yawe ahantu hari imiswa kuko nta muti wirukana imiswa burundu wari waboneka
- **6.7 Gukurikirana imikurire y'ibihumyo**

Utwikurura ya shashi buri munsi mbere ya saa moya za mu gitondo mu gihe cy'igice cy'igice cy'isaha (iminota 30) , ukavomerera, ukongera ugatwikira,

- Mu gihe izuba rirenze ukaza kongera gutwikurura igice cy'isaha, ukavomerera,
- **6.7 Gukurikirana imikurire y'ibihumyo**
- Ibyo bikorwa kugira ngo ibihumyo bizamuke neza kandi binahumeke umwuka mwiza,
- Mu gihe cy'izuba ryinshi, birashoboka ko ubutaka bwumagara, icyo gihe rero ushobora gusuka amazi ku mpande z'umutabo watewemo imigina.

*Umuhinzi w'ibihumyo yirinda **gusuka amazi ku bihumyo** bizamuka*

kuko ashobora kubyanduza cyangwa se kubyangiza cyangwa akaba

yatuma itaka ritarukiraho umusaruro ukaba mubi.

6.8 Ibibangamira imikurire y'ibihumyo

Ibihumyo bikura, bishobora guhungabanywa no kubura ubuhehere buhagije, kubura **umwuka mwiza** bikeneye ngo bikure, cyangwa se **kurwara** ku mpamvu zitandukanye, cyangwa se bikangizwa n'**ibyonnyi** nk'imbeba, inzukira, imiswa, ibinyamunjonjorerwa n'uducurama.

- **6.9 Gutunganya ubuhinzi bw'ibihumyo muri rusangi**

Mu rwego rwo kwirinda ibi bibazo byose ni ngombwa:

- Kubaka igisharagati no kwita ku migina wubahirije amabwiriza yatanzwe,
- Kugira isuku ihagije,

- Kwirinda amasazi mu gisharagati,
- Gufunga umuryango waho bihinze mu gihe ibyahakorerwaga birangiye,
- Kugenzura uburwayi no kubukumira hakiri kare, ukamenyesha abakugurishijeho imigina cyangwa abaguhuguye igihe ubunye ikibazo.

- **6.9 Ubuhinzi bw'ibihumyo muri make**
- Iyo umaze gusarura, ukora isuku kugirango ibisigazwa bitahaborera ngo bitera indwara,
- Kuvanamo ibisigazwa by'imigina byose yasaruwe no gutunganya neza umutabo mbere yo kongera gutera indi migina.
- Umugina nturenza amezi ane mbere yo kujugunywa ngo haterwe undi

7. Gusarura ibihumyo

Ubu bwoko bw'ibihumyo busarurwa **ingofero ikigondeye imbere**, ni ukuvuga itararambuka neza. Iyo irambutse, igihumyo gita ibiro.

Ibihumyo bisarurwa mu **gitondo mbere y'uko izuba riva** cyangwa se **nimugoroba izuba rirenze**. Ufatisha ibiganza byombi ugasa n'ufungura ivisi ujyana mu ruhande rumwe ukagarura mu rundi, hanyuma ukazamura witonze kugira ngo umugina utangirika.

Umusaruro w'umugina iri hagati ya 600g na 1 kg kandi usarurwa igihe kiri hagati y'amazi atatu cyangwa ane.

- Isuku ni ngombwa cyane kubera ko ibihumyo byandura vuba. Umuntu yirinda umwanda wose cyangwa amazi yanduye.
- Birabujijwe k**uvuna igihumyo** kuko igice cy'umurundugushu kiramutse kigumye mu mugina, cyabora kigatuma wangirika bityo ibindi bihumyo ntibishobora gushibuka.
- **U8. Kubika neza ibihumyo byasaruwe**
- Ibihomyo byiza ni ibisarurwa bigifite itoto kuko ari byo bishimwa ku masoko kandi biryoha kurushaho.
- Iyo ibihumyo bisaruwe bigifite itoto, bisigira ibizashibuka intungamubiri zihagije.

- Iyo umuhinzi atinze gusarura kugira ngo umusaruro ube mwinshi ibihumyo bikurikiye ntibiba byiza nk'ibyabibanjirije.
- Ibihumyo byiza biba bisukuye nta taka bifite.

- **I9. Igihe ibihumyo bimara mu mutaro**

Imigina imara mu mutabo hagati y'amezi atatu n'ane. Iyo ubonye ibihumyo bitakizamuka, upfukuraho ya shashi mu gihe cy'iminsi irindwi (7), nyuma ukongera ukavomerera ukanatwikira nka mbere; iyo na none nyuma y'icyo gihe nta kizamutse, ni uko iba yahunduye, iba igeze igihe cyo gusimbuzwa indi.

10. Akamaro k'imigina ishaje

Umugina wahunduye ushobora gukoreshwa ibintu bitandukanye: **Kongera ugakoreshwa indi migina** (ariko ibanje gutunganywa), **imborera** no **kuwugaburira amatungo** nk'ingurube, amafi n'inkoko. Ubwatsi bugize umugina wahunduye burimo imyunyu y'ingenzi igize inyongeramusaruro. Iyo myunyu ni Azoti, Fosifori na Potasiyumu ikoreshwa mu buhinzi busanzwe.

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