Efficient Water Use for Agricultural Production (EWUAP) Project

BEST PRACTICES FOR WATER HARVESTING AND IRRIGATION

Rwanda

INTRODUCTION

I.1 Objective/Requirement of the study

The present study is focusing on achieving the following five main objectives: (1) Establish referential norms and criteria for identifying and ranking Rwandan (community, public and private) water harvesting and irrigation best practices, (2) Constitute a clear description (technical, socio-economic and institutional) of the preeminent sites of water harvesting and irrigation best practices, (3) Establish a list of key local institutions having the potential ability of running capacity building activities as well as field trials demonstration for the best practices in water harvesting and irrigation, (4) Identification of gaps in the existing water harvesting and irrigation practices.

I.2 Approach and Methodology used.

Achievement of the above outlined objectives will be conditioned by a keen work undertaken using the following methodology. The first step of the study will focus on compiling available literature provided and searched in several national libraries and come up with a summary of criteria of best practices of water harvesting and irrigation. Those criteria will be used to select preeminent sites where best practices are being applied for water harvesting and irrigation. The next step will concern with establishing a list of water harvesting and irrigation sites and to classify them in terms of community, private, and Public managed sites. The established long list will then be subjected to the criteria of best practices and a short list of preeminent sites will be extracted from the long list. The preeminent sites will be visited and described on the light of guidelines provided. Data related with technical, socio-economic and institutional aspects will be collected during field visit using the format provided. Potential training institutions will be visited and training programs related with water harvesting and irrigation will be identified and described. Finally' information collected will be reported following the reporting instructions provided.

II Criteria for Prioritization of potential for best practices and best practice sites and schemes

II.1 Agro Ecological Zone (AEZ)

Twelve Agro-Ecologic Zones are currently recognized in Rwanda. As observed on the Map 2 and described below, those zones have been determined based on the climate, the soil suitability, the geology and the geomorphology (Verdoodt, 2003).

Imbo

The Imbo, located in Southwest Rwanda, is the smallest agro-ecological zone. Its centre, made up by the alluvial valleys of the Rusizi and Rubyiro (Congo bassn), includes the lowest point of the country, at an altitude of 970 m. A series of mountain ridges However, attaining an altitude of 1,400 m characterize its borders. An average. Temperature of 24 °C and a dry season of 3 months characterize the tropical climate conditions. The annual rainfall totals increase considerably from about 1,050 mm in the South to 1,600 mm in the North. The high temperatures and abundant rainfall together with the good quality alluvial soils and the possibilities for irrigation offer many possibilities for an intensive and productive agriculture. Indeed, one of the best practice sites of irrigation is located in that AEZ (Bugarama project)

Impara

The Kivu Lake, the Imbo and the forest on the Congo-Nile Mountain Ridge border the second agricultural zone of the Impara. Its altitude ranges between 1,400 and 1,900 m. With increasing altitude, the annual rainfall increases from 1,300 to 2,000 mm, while the temperature decreases from 22 °C to 19 °C. The very fine clayey soils, developing from basalt, have a high agricultural potential at least if they are not leached out by the abundant rainfall. The mild climate, associated with abundant rainfall, generates optimal conditions for the cultivation of a number of traditional and industrial crops

Kivu Lake Borders

The shores of the Kivu Lake, extending from an altitude of 1,460 m near the lake up to 1,900 m on the western slopes of the Congo-Nile mountain chain, constitute the third agricultural zone. The lake tempers the climate of the region, characterized by a temperature ranging between 19 and 22.5 °C and an average annual rainfall between 1,150 and 1,300 mm. Nevertheless, within the agricultural zone, clear differences in rainfall amounts have been recorded. The South and North are clearly more humid than the central region of Kibuye. With respect to the soilscape, moderately fertile soils developing on shales and granites have been recorded on the gently sloping hillsides, while the abrupt slopes are strongly eroded, leaving skeletal soils.

Birunga

The agro-ecologic zone of the Birunga groups the volcanic soils that descend from the limit of the national park at an altitude of 2,500 m to an altitude of 1.900 m near Ruhengeri and even below 1,600 m near Gisenyi. Regularly distributed rainfall, varying between 1,300 and 1,600 mm and

fertile soils create favorable conditions for agricultural production. Limitations due to the generally limited soil depth have been removed by cultivating the crops on small ridges created when ploughing or harrowing the fields.

Congo-Nile Watershed Divide

The fifth agro-ecological zone occupies the highland area, extending from the Nyungwe forest in the South to the Gishwati forest in the North, that divides the country into two watersheds. All rivers on the left side of this mountain chain drain into the Congo River, while all rivers on its right side drain into the Nile. The lower altitude boundary is 1,900 m and corresponds to the altitude above which most crops of the tropical lowlands are badly adapted. The tops of the mountain chain surpass an altitude of 2,500 m. In the North, the annual rainfall varies between 1,300 and 1,500 mm, while in the South annual rainfall totals between 1,400 and 1,800 mm have been recorded. On the mountaintops in the Nyungwe forest, it rains more than 2,000 mm annually. This abundant rainfall has totally leached the soils that were developing from poor parent materials such as sandstone, quartzite, quartzophyllite and granite. Where the forest has been cleared, also the mineral reserves of the litter layer are rapidly consumed and poor soils are left. Although the inhabitants improve the soils near their residence and cultivate several traditional crops, this region has a vocation for forestry in the first place.

Buberuka Highlands

In the North of Rwanda, high altitude plateaus traversed by quartzitic chains that attain an altitude of 2,300 m characterize the agricultural zone of the Buberuka Highlands. Its the lower altitudinal limit corresponds to 1,900 m. It rains about 1,200 mm annually and there is a dry season of 2 months. The soils of this region are generally more fertile than those of the Congo-Nile Watershed Divide, leaving more options for agricultural production. Nevertheless, also in this region, the potential for forestry is high.

Central Plateau

The large region of hills and valleys between the Congo-Nile mountain chain and the Granitic Ridge, at the centre of the country, is referred to as the Central Plateau. At an average altitude of 1,700 m, the annual rainfall amounts to 1,200 mm and the average temperature attains 19 °C. If the humus-bearing horizons are conserved, the soils can be used for the cultivation of a whole range of climatically adapted

crops.

Granitic Ridge

The agricultural zone of the Granitic Ridge, differs from the Central Plateau because of its soils developing on granitic material. Its average altitude is 1,600 m and the annual rainfall is about 1,100 mm. The convex ridges and rounded, gravelly hills are used for pasture and forest. Crop cultivation is mainly concentrated on the concave hill slopes.

Mayaga

The Mayaga constitutes a narrow agricultural zone, extending over the two borders of the Akanyaru River. In the northern part, the landscape is characterized by hills and valleys that are regularly inundated. The altitude varies between 1,350 and 1,500 m. The landscape of the southern part is much more abrupt, rough and dominated by quartzite chains. Next to differences in topography, the southern part is also characterized by slightly higher annual rainfall totals, varying between 1,100 and 1,200 mm. In the North, it rains about 1,000 to 1,100 mm annually. Also the soilscape is strongly variable. Rock outcrops characterize the hill tops. Humus-rich, gravelly soils are found on the upper slopes, while the younger soils of the foot slopes generally have a higher productivity.

Bugesera

The Bugesera is a large plateau located at an altitude of 1,300 to 1,500 m and bordered by the fluvial depositions of the Nyabarongo. A more recent erosion cycle superimposed a new drainage system and resulted in a landscape of smaller isolated plateaus with deep strongly weathered soils, intersected by dry valleys with very gentle slopes. From a climatic viewpoint, this agricultural zone is dry and warm, characterized by an annual rainfall varying between 850 and 1,000 mm, a dry season lasting for three months and an average temperature of about 21 °C. The best soils for crop cultivation are found on the colluvial deposits bordering the marshes and lakes. Nevertheless, the agricultural potential of this region is generally low and the region mainly has a pastoral vocation.

Eastern Plateau

North of the Bugesera, Delepierre (1974) defined the agro-ecological zone of the Eastern Plateau. This vast zone, located at an altitude of about 1,500 m is in fact the extension of the Central Plateau into the drier East. The landscape is characterized by hills with large, horizontal tops and steep slopes. In the eastern part of this region, enormous quartzite ridges cross the landscape. It

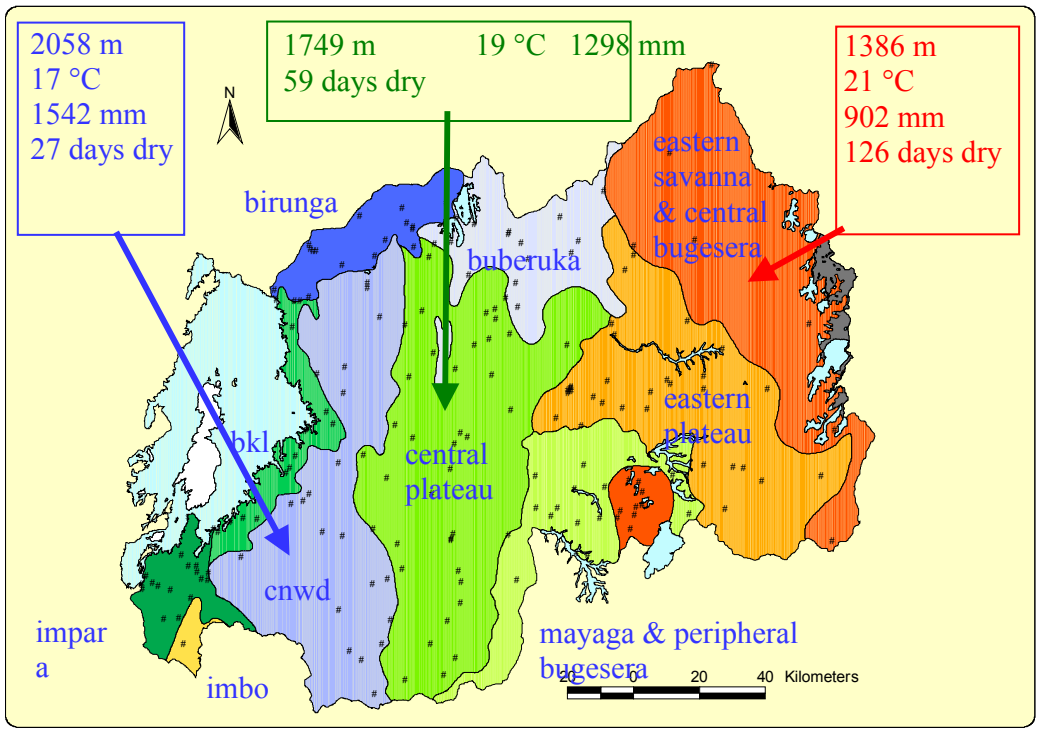
rains about 900 to 1,000 mm annually. The hilltops are covered with deep humus-rich soils. On
the convex upper slopes, outcropping laterite crusts and gravelly soils have been reported. The fields on the steep slopes are strongly eroded and are mainly used as pasture land. In the East, shallow degraded soils dominate the soilscape and only the soils of the foot slopes have some agricultural potential.

Eastern Savanna

All the lowlands in the extreme East of Rwanda belong to the Eastern Savanna. This agro-ecological zone is characterized by a gently sloping landscape with hills that are intersected by large valleys. The altitude generally varies between 1,250 and1,600 m. Climatically, the region is warm and dry. The average temperature is about 21 °C, while the erratic rainfall amounts to less than 900 mm annually and the dry season lasts for 4 months. The best soils of the region are those with some vertic properties, found in the large valleys. Nevertheless, they still require some important investments in irrigation and machinery. As such, also this region mainly has a pastoral vocation

The agro-ecologic zones are somewhat overlapping the climate zones except the Central plateau climatic zone which is covering both Central Plateau and granitic ridge agro-ecologic zones as shown on the Map 1below

Figure 1 :Map 1:Rwanda Climate

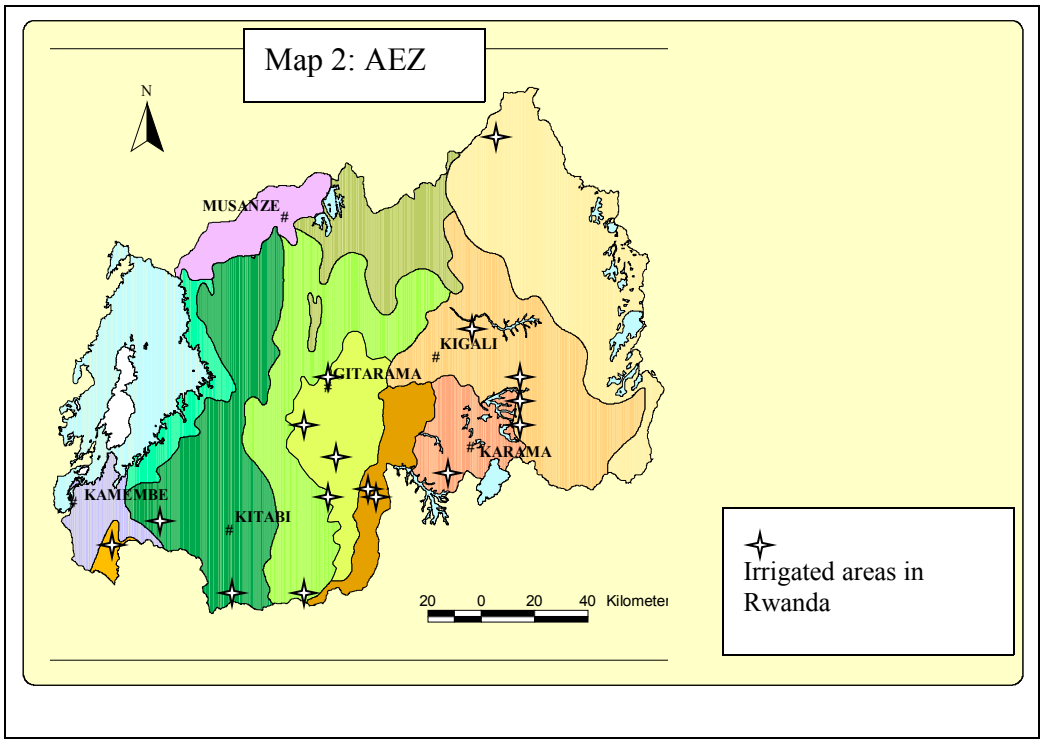


II.2 Water harvesting and Irrigated Areas in Rwanda in relation to AEZ.

Currently the surface irrigated in Rwanda reaches 13000 ha on an irrigable potential of 170.000 ha of the marshes, that is to say 7.6% (Barigira, 2008). The major part of irrigated lands is in the marshes and is cultivated out of rice. Irrigated rice production contributes enormously to the livelihoods and incomes of farmers in the country whereby 70% of rice is produced in the country. According to the Ministry of Agriculture (2006), the planning for irrigated area for rice production, the area coverage which will be occupied by rice crop is estimated to 66 093 ha in 2016 with the Southern and the Eastern province contributing to more than 80%. The FAO (2005) and AQUASTAT (2005) reported that in 2000, the water use in Rwanda was estimated to 150 million m^3/an and agriculture was considered as the main consumer with more than 68%. On a total of 165.000 ha to be irrigated, only 8,3% are equipped with irrigation systems. Among them 62% are equipped with water control facilities (HARINDINTWALI, 2006). In general it is estimated that marshland reclamation and hillside irrigation will make possible the food subsistence in the near future (FEWS NET 2007).

Irrigated areas (Figure 2) in Rwanda are mainly concentrated in the South, Central Eastern parts of the country. In the southern parts the of Impala and Imbo, the southern and the central part of the central Plateau. The total surface area irrigated is estimated to 62 252 Ha (Barigira, 2008). In 2000, the water use in Rwanda was estimated to 150 million m^3/an. Agriculture as principal use consumed 68% whereby rice crop practiced on 8.500 ha would have used approximately 25.500.000 m^3 (Rapid base line). Among those only 62% are equipped with water control facilities. According to FAO (2005), on a total of 165.000 ha to be irrigated, only 8,3% are equipped with irrigation systems.

Figure 2: Agro-Ecological Zones versus water harvesting/Irrigation sites



III Identification and Assessment of Best Practices/Technologies

III.1 Selection Process and Salient futures

This section will be devoted to define the nine criteria chosen to be considered in order to screen water harvesting and irrigation best practices. Criteria are mainly related to the sustainability, affordability, economic profitability and the impact on the environment. Technical aspects are also taken into account.

III.1.1 Water harvesting best practices criteria

III.1.1.1 Sustainability of water source.

Assurance of the sustainability of the source of water is very important to justify investment. Sources for water harvesting need to provide water permanently or at least periodically. Although the natural sources could be affected by the dry season, the decrease in water should not be significant. Water collected from rainfall (on ground or from house roofs) will be given less importance, however, some community water harvesting in the North-Eastern province will also be taken into account.

III.1. 1.2 Efficiency of the harvesting technology

The efficiency of the technology used to harvest water is also given importance. Indeed, the technology either indigenous or modern has to fulfill some standards in order to be considered as a best practice. The structures must be of good quality in terms of building materials and water caption system and water release mechanisms. In Rwanda, water caption by gravity and pumping (Kigali Nyacyonga) are the main water caption used.

III.1.1.3 Water storage

The storage must be designed to limit at maximum losses of water by licking, infiltration, seepage and /or evaporation. The system should be constructed in such a way to ensure the quality of water with regards to the type of water use. Organic residues should not occur in the stored water to reduce organic matter anaerobic decomposition which could yield some toxic gasses (methane,..). In case the water is collected for multipurpose uses including drinking, more precautions have to be taken.

III.1.1.4 Environmental impacts

The water harvesting system should not affect negatively the existing ecosystem equilibrium. In addition, the water harvesting should not at any extent impact on the soil water content of the surrounding area. An increase or a decrease in soil water content could disturb the existing fauna and flora. It has been unfortunately observed that in some cases, the drainage of water harvesting purposes was accompanied by a drying of the sites and has leaded to an excessive oxidation process and a drastic organic matter decomposition and hence a decline of soil water holding capacity.

III.1.1.5 Level of community participation

This is another key criterion of best practices. The level of community involvement is one of the most important components which must be taken into account. The community should be involved from the design up to the use levels. A visible community hand should be observed in all activities including decision making level.

III.1.2.6 Viability and affordability to rural communities

In the specific case of community managed water harvesting, the viability and the affordability by small scale farmers is considered. The cost of the technology used should be cheep enough for resource poor farmers or the use of water should bring enough income to allow the maintenance of the overall water harvesting system.

III.1.2.7 Level of farmers experience in water harvesting potential and constraints

It is also important to take into account the level of experience of the farmers in terms of mastering the technology used as well as over coming constraints arising from the water harvesting practice.

III.1.3 Irrigation best practices criteria

The irrigation system consists of a (main) intake structure or (main) pumping or a gravitational station, a conveyance system, a distribution system, a field distribution system, and a drainage system

III.1.3.1 Water transport using open structures

Channels and canals, field ditches must be well constructed to allow the conveyance of water from the main waterways supplying water to one or more farms. The conveyance system should allow the transport of water from the main intake structure up to the field ditches without significant losses. The water transport technology applied must limit the water loss by infiltration or any other kind of leaking. The construction of the canals has to be well engineered in such way to allow the optimum water transport

III.1.3.2 Water distribution system

Water distribution from the principal canal to the secondary and tertiary canals must be efficient. Water distribution structures (division boxes, etc…) must be technically well built and sustainable.

III.1.3.3 Water drainage system

The drainage system which removes from the field the excess of water (caused by rainfall and/or irrigation) must be technically well calibrated to remove just the excess of water. The over all drainage structures shall allow a good control of quantity of water to be removed. Drainage systems bad calibrated could result in excess of drainage and an over oxidation reactions which yield a decrease in soil water holding capacity.

III.1.3.4 Environmental impacts

It is often observed that irrigation influences the solubility of some metal such Fe and Mn which at a given concentration could be toxic to the environment. In addition Nitrogenous fertilization of rice paddies could to an excess of nitrates ions in the drained water and this could contaminate ground water.

III.1.3.5 Level of community participation

This criterion is of great importance for community managed irrigation.

III.1.3.6 Level of income to local population

The income provided by the agricultural activity must be significant and must contribute significantly to the poverty reduction. The activity must be economically profitable and sustainable

III.1.3.7 Level of good agricultural practices adoption

The sites should demonstrate the capacity of efficient use of soil fertility amendments (mineral and organic), good agricultural system (crop rotation, mono cropping, agro forestry, weeds control, improved fallow practices,…)

III.1.3.8 Viability and affordability to rural population

For community managed irrigation, the technology should be affordable by the resource poor small scale farmers,

IV Identification and Assessment of Best Practices Sites

IV.1 Selection Process, Salient futures, and Results

The selection process will be based on the criteria outlined in the section II above. Water harvesting systems and irrigation systems will be subjected to the criteria selected.

IV.2 Water harvesting

IV.2.1 Long list of best practices sites

Table 1 Long list of water harvesting (Valley dam:VD, Water ponds: WP and Roof water harvesting:RWH) sites

Site name	Type	Sector	District	Province	GPS

Rwibishorogoto	Valley dam		Nyagatare	Eastern	
Rwmiyaga	Valley dam	Rwimiyaga	Nyagatare		
Rukindo	Valley dam		Nyagatare		
Gakagati	Valley dam		Nyagare		
Kiyovu	Valley dam		Gatsibo		
Kiyovu	Water pond		Gatsibo		
Kanyonyomba	Valley dam		Gatsibo		
Cyabayaga	WP		Nyagatare		
Muvumba	RWH	Rukomo	Nyagatare		
Nasho	On field rain water harvesting		Bugesera	Eastern	
KISARO	Radical terracing		Gicumbi	Northern Province	
Kigali urban area	RWH			Kigali City	

IV.3 Community Managed (Small Scale) Irrigation sites

Confused with public/community managed irrigation sites

Iv.4 Public/community irrigation

Iv.4.1 Long list of best practices sites

Most of the community managed irrigation is situated in the Southern province

Table 2 Long list of Community managed Irrigation sites in Rwanda

Site name	Cell	sector	District	Province	GPS Cord.

Biringanya				South	
Munyazi	Nyanza		Huye		Elev: 1682 m; 02°33'53.4''(South); 029°43'21.1''(East)
	Rukira				
	Nkima				
	Sovu				
Rwasave		Mbazi	Huye		
		Kibirizi	Gisagara		
		Save			
Mukunguri			Ruhango		Elev:1625 m Lat: 2º40' S Long:29º45' E

Iv.4.2 Evaluation of best practices/technologies See Field report)

IV.5 Public/Private/Community Managed (Large Scale) Irrigation

Long list of best practices (in a tabular form)sites

Table 4 Long list of Public/community managed Irrigation sites in Rwanda

Rugeramigozi 1 (Public/Private/Community)	Gahogo	Rugeramigozi	Muhanga	S	Lat: 02°06'29.9'' an S and Long: E029°45'09.6''
Gahenerezo (Public)	Gahenerezo	Ngoma	Huye		Lat: 02 35 12 S Long: 029 44 02 Elevation: 1670 m
Rwasave 1		Ngoma	Huye		Elev:1625 m Lat: 2º40' S Long:29º45' E

Kanyonyomba			Gatsibo	East	
Gakirage		Nyagatare	Nyagatare		
Gashora			Bugesera		
Nasho					
Codervam-Ngarama			Muvumba		
Nyacyonga (sprinkler)	Nyacyonga		Gasabo	Kigali	
Kabuye			Gasabo	Kigali	
Mulindi (sprinkler)	Mulindi			Kigali	
Nyacyonga (drip Irrigation			Gasabo	Kigali	

IV.6 on situ water harvesting: Radical terracing

It is also important to note key water harvesting on situ using radical terracing. This practice is widely applied in the whole country where step slope are occurring. As the Eastern and southern part of the country is more likely to have irrigation schemes, the Northern part of the country will be more appropriate to terracing for soil and water conservation. Indeed the terracing increases infiltration rate and reduce the run-off significantly. The increase in soil moisture content improves soil fertility parameters and hence improves agricultural production (Clay et al1998).. The efficiency of the radical terracing is based on the reverse of the slope: rain water is running in the opposite direction of the natural slope and at a very slow velocity. With time, it is also expected to recharge the ground water resources (Alton and Byers 1992)... Below two photos are showing to illustrate the changes in landscape due to terracing.

Figure 3: Photos of land scape before terracing

Figure 4: Photo of a section of the landscape after terracing (KISARO)

V Field Visit, Findings in Relation to Expectations and final short list

On the light of theoretical selection of best practices sites and best technology criteria, field visits have been organized in several preeminent sites. In the Eastern province, the sites of, Gashora, Gakirage, Cyabayaga, Kanyonyomba, Rwimiyaga and Muvumba were visited. Other sites visited were situated in the southern province (Gikonko, Rwasave) as well as Kigali City and southern part of the western province (Bugarama: Congo basin). The detailed description of the visited sites and photos are shown. It is important to note that all the visited sites were not selected as best practice sites. However the information collected on those sites is summarized in the appendices section.

V.1 Short Listing and Ranking of Best Practices/Technologies (in tabular forms)

As requested by the client, the report of information collected from the field is summarized in tables below. Photos illustrating the water caption, water conveyance, water distribution and water use will be displayed d at the beginning of the report of every site. In Rwanda, Most of the sites are some how receiving a government support especially for infrastructures installations as well as collecting taxes after development since the land Law provides that all marshlands belong to the State.. It will be therefore seldom to see a site where the government is not involved. For new sites, the government

intervenes by developing the marshlands by making sure to involve the farmers and the farmer's cooperatives undergo redistribution of better organized plots to the farmers.

IV. 1 Public/ Community managed irrigation

IV.1.1 Kanyonyomba site

a) Water harvesting system: Valley dam

c) Water conveyance system

IV.1.2 Rugeramigozi site

Illustration photos

Figure 4: Water harvesting: Valley dam

Figure 5: Water exit from the dam to principal canal 1

Figure 6: Plot receiving little water for vegetables and maize cropping

V.1.3 Rwasave

Figure 7: Water caption system

Figure 8: COAURWA rice cropping

IV 1.5 Bugarama marshland site

This site is considered to the most important site in terms of quantity of water used, surface area covered by rice cropping as well as irrigation infrastructure as outlined below

Figure 10 Déviation Barrage and de-siltation system (Bugarama)

Figure 11: Water caption system (Bugarama)

Figure 12: Water oxygenation and transfer in the Primary canal (Bugarama)

Figure 13: Water conveyance: primary canal (Bugarama)

Figure 14: Water level control system

Figure 15: Water Distribution system (deviation box)

Figure 16: Watering rice plots (Bugarama)

VI Prioritization and Selection processes and Results

Among the best practices, the prioritization should be based on the economic and environmental criteria. Some small scale water harvesting and irrigation schemes might not be important in term of actual productivity but might be of great importance considering the potential of natural

resources and vision 2020. Indeed some site should given priority and extended in many areas where technically possible.

- Valley-dams, Roof water harvesting and ground water harvesting in the Eastern Savannas and Eastern plateau
- Valley dams in the Mayaga
- Stream deviation in Central granite AEZs and in the Central Plateau
- Terracing is the most appropriate in the North of the country as well as at the Congo-Nile division highland AEZ
- Sprinkling and drip irrigation are priorities in town suburbs and in areas where cash crops are being developed. Like in Bugesera and Kigali city

VII Guidelines and Related Issues Considering Country Experiences in relation to the three components

After considering the results of this study, following guidelines could be drawn with regards to Water harvesting, Community managed irrigation and Private/Public managed irrigation:

1. Water resources: A comprehensive study needs to be carried out in order to highlight the potential amount of water available in every single watershed. A database would there be established and validated and would be used to predict agricultural production.

2. Soil properties: In addition to water database, a continuous soil fertility assessment should be conducted to monitor soil behavior changes and proposing proper crops to be practiced every season taking into account the water database. This should also help to assess toxic pollutant toxicity originating from fertilizers, pesticides and the water logged condition of soil.

3. Agricultural policy for agricultural investors: It is highly recommended that the government thinks about attractive incentives strategies to encourage large scale private investors to invest in agriculture. This would probably be the best way to enhance agriculture production and make it a competitive income generation alternative to other

business activities. A number of scenarios used in other countries could eventually be tried here. For instance, it would be more practical if some business men were investing in water harvesting and provide water for farmers. In this case, the farmer work would facilitate and he gets more time to concentrate on other farming activities and hence improving the production.

4. Technology: We assume that there is no gap in terms of technology since several institutions are available and are providing high standard skills. In addition to that, Rwandan farmers have a very long experience in water management

VIII Impact of best Practices/technologies on overall efficiency of water use

The best practices in efficient water use for agriculture are having a significant impact in the overall water availability. For instance, the case of valley dam construction in the Eastern province as mentioned above had positively influenced both agricultural and livestock production. Efficient water storage decreases water shortage during dry seasons and allows an addition production. An other important impact has been a decrease in soil erosion where rain water is harvested. This is made possible by the significant reduction of runoff and an increase of water infiltration for ground water recharge.

IX Evaluation of limitations and opportunities of the described best practices / technologies for replication and scaling up

It is not obvious to evaluate limitation and opportunities of best practices at present, since very few comprehensive investigation have been done in terms of potential water and land resources availability. On the other hand, human resource capacity is also not clearly established. However some limitations and opportunities could be proposed as assumptions.

Major limitations of best practices

Human resources capacity: People having the know how in terms of water harvesting and irrigation technology are nor mobilized and are not practicing due to poor organization. Civil servants working in public institutions are not often seen on field partially due to high costs of field visit. Although farmers are doing their best to produce, they are still struggling with water

control due poor technology and un calibrated canals for water distribution. Until now no large scale farmers are investing in agriculture due to uncertain market and subside. Low fertility and fertilizer mismanagement could also contribute to limit agricultural production.

Opportunities

A good agricultural policy has been established to ensure a better organization of agricultural sector. The Ministry of Agriculture is showing commitment in making sure that all component are provided for a sustainable agriculture. The Government of Rwanda through the Ministry of Land had recently promulgated the Organic Land Law and a number of application orders and decrees which are providing a room for a better land tenure. The Land Use Master Plan being n track will also contribute to a more efficient water use for agriculture. Enough water resources are also available for being used in all sectors and more specifically in agriculture production. Training, research, funding, extension support institutions are also available in the country and most of them are of good standard as outlined below.

Best practices could be replicated in other areas and even be improved sine farmers have a long experience in water handling technologies for agricultures production as well as, fish and livestock production.

X Potential Cooperating National Stakeholders/Institutions for Field Level Demonstration of best practices (Inventory of Institutions for twinning)

Below is the list of potential private and Public institutions and/NGOs offering capacity in terms of technical, policy, funding, training, demonstration on field, …

Institution	specialization	Addresses	Support area
1National University of Rwanda (NUR) -Faculty of Agriculture -Department of Soils and Environment Management -Post Graduate Diploma in Irrigation and Drainage	Irrigation and drainage	Butare, Cell 250 08874486	Training and field demonstration

Faculty of applied Sciences (NUR)	Water resources and env. management	South, Huye, Butare, 25008874486	Training and field demonstration
Institution	Specialization	Address	Support area
Rwandan Institute of Research	Rice and horticulture specialist	South, Rubona, 08410742	Field trials and research
Kigali Institute of Science and Technology	Irrigation and water harvesting infrastructure	Kigali	Training and maintenance of infrastructure
ISAE	Rural development engineering	North, Musanxe, Ruhengeri	Training and monitoring
Institution	specialization	Addresses	Support area
Ministry of Land	Policy,	Kigali	Funds
Ministry of Agriculture	Policy	Kigali	Funds
Min science and tech (President's office)	Policy	Kigali	Training
Rwanda Agricultural Development Authority		Kigali	Extension, monitoring and evaluation
Rwanda Horticulture Development Authority		Kigali	Extension, Monitoring and evaluation
Institution	Specialization	Addresses	Support area
Rwanda Livestock Development Authority		Kigali	Extension, monitoring ad evaluation
Rural Sector Support Project (RSSP)		Kigali	Technology extension and monitoring and evaluation
Local government			Involved in all kind of activities
Agro-Action Allemande		Kigali	Funds and training
Institution	Specialization	Addresses	Support area

UNDP		Kigali	Funds
ADB		Tunis-Kigali	Funding
World Bank		Kigali	Funds

CONCLUSIONS

This study could be considered as a successful and original work because very few studies with regards to the efficient water use for agricultural production have been done. This study contains key baseline information on the main water harvesting and irrigation schemes occurring in the country. It has been hard to categorize different sites due to the multi partnership existing for Rwandan marshlands development and use. The main category observed was the Public/Community managed irrigation. It is seldom to find in Rwanda water harvesting and/or irrigation schemes managed by private or public institutions without involving community. Six Sites (Kanyonyomba, Rugeramigozi, Rwasave, Cyili and Bugarama) have been short listed as the best practices with regards to efficient water use for agricultural production. A small scale good practice of Roof water harvesting managed by the community of Muvumba sector (Eastern province needs to be mentioned here although its low economic impact excluded the site among the best. Other small scale practices to be developed are the sprinkler and the drip irrigation applied in Kigali City for horticulture production.

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Annexes

Date of Visit 14th November,2007	Category: Farmers' cooperatives supported by RSSP, are applying a flooded/basin irrigation for rice production
Name of Site: **Kanyonyomba marshland**	
Geographic location of practice: Gatsibo District – Eastern Province	Sketch Map of Site
(GPS) Coordinates:	
Description of the Community: Members: …Gender: 40% Women, Age: 70% Between 18 and 40 years, education: 20% primary school	
Characteristics of the area: Fertile soil, good water holding capacity due to a good Org Matter content	
Climate (AEZ) + Description: Eastern plateau, It rains about 900 to 1,000 mm annually Low altitude with relatively high temperature and water scarcity	
Average annual rainfall (900 mm)	
Months of Short Rains:	
Months of Main Rains:	
Mean annual ref. crop Evapotranspiration (mm):	
Predominant soil type: humus-rich soils	
Topography: Relatively flat lands dominated	
Slope:	4%
Erosion: Not significant	

Period of year during which used: September-December and March-May	
Period of year during which benefits utilized: The benefits are utilized after harvesting and selling their productions by June and January	
Water Source: Stream water (name??) is here considered as the main source of water harvesting	
Cultivated area:	
Technical Description: The system consists of using basins which are pieces of land, small or large, surrounded by earth bunds in which water is ponded. The water "disappears", either via an escape drain, or through infiltration and drainage, unless it has evaporated into the air. The basin surface is formed into mounds or ridges. Floodable basins, water off take supply canals, siphons, a drain, main earth banks, secondary bunds, gates and diversions structures are the main components of Flooded irrigation. The system is used for rice production. The water is distributed by gravity "a barrage".	
Technical Details: study is here mentioned as preliminary study mostly carried out. Relevant reports and design data used in designs are available. (Source: RSSP)	
Useful in: The system can be used allover the country, provided the available water supply is not a constraint.	Limitations: The Monocropping could lead to progressive infertility of the soil due to nutrients export by rice. The main source of water comes from rainfall.
Geographical extent of use: It will be advisable to use this practice of irrigation on streams or rivers in relation with Nile Basin to ensure rational use of water in the system.	Effectiveness: Very effective. Members of the cooperative assume to have increased their life style using the production of rice.
Other Sites where used: In most of marshlands managed by RSSP allover the country (Cyarubare, Kibaya-Cyunuzi, Bugarama-Nord/Sud marshlands…)	

Cost: The method requires elevated costs 2,000-4,000 $/ha for irrigation (the barrage for Kanyonyomba marshland was estimated at 1 billion).	Operation and Maintenance arrangements: The cooperative is in charge of maintaining the infrastructures
Benefits: Considerable benefits were realized since 2000, where the production increased from 11949.29 tones/ha to 52444.7 tones/ha in 2006.	Water User Association or User Group: Water user association
Stakeholders and beneficiaries: The stakeholders in this system implementation are mainly, BAD, World bank (funders), local administration, RSSP and RADA, Beneficiaries: Farmers (users), local administration (taxes). Level of involvement of beneficiaries: Local administration (supervision of the activities), farmers (regularly maintenance during exploitation). Who are the main beneficiaries	Enabling Environment: New ecosystem created by the availability of water. (Animals and Plants, aquatic plants) beneficiary involvement demand based interventions
Training support: Actually, RSSP and RADA are conducting trainings for farmers starting by association management skills followed by the maintenance of installed infrastructures. But no training on irrigation systems	Extension support: Provided by the Ministry of Agriculture via Rwanda Authority for Agriculture Development (RADA)
Environment benefits: The system prevents marshlands from drying, hence a kind of water resource management and soil conservation. use of rice residues for bricks fabrication, Animals are feeder using factory sub-products and produce organic manure for soil amendment.. This prevent the excessive use of trees and grass and hence preserve the environment Sustainability economic aspects	Social/Cultural acceptability: 80 %

cultural environmental aspects technical	
Advantages: -Income generation for poor farmers-Environmental benefits(better use of water resources, decrease erosion and increase ground water recharge,…	Disadvantages: The area flooded by the dam has lost the indigenous biodiversity; people have lost their plots although they got new plots far from their household.
Scaling Up: The technology could be extended to some other areas in the Eastern province and in the entire country	What is potential for applying all/parts of initiative elsewhere? The water harvesting technology (valley dam)
	I [ ] Transfer of practice to another group/culture/land-use system, etc. 8
	II [ ] Easy to transfer the practice, but with minor adaptations for local conditions
	III [ ] Transfer possible, but significant modifications/prerequisites to consider. 3
	IV [ ] Difficult to transfer the practice. Need experienced support.
	V [ ] It would be impossible to transfer the practice. Too site specific.1
	Other specific remarks: Private sector need to encourage to join and enhance investment because the project has a potential of 66 000 ha ha for the moment only 9 600 ha are used
Best Practices: Sustainable water source, Efficient water storage and distribution, High standard infrastructure and Community participation	

Contact Organization: Public organization: MINAGRI: RADA/RSSP Contact person: E. CYUBAHIRO-RADA, Tel: 08748357 G. Niragira-RSSP		
Type of organization:	Contact person:	
[ ] government organization YES (30%)	Contact details	
[ ] private organization		
[ ] NGO &/or CBO		
[ ] international agency		
[ ] Community : 70%		
Lessons learnt:		
Planning: Good engineering plan taking into account the quantity of water resources and soil productivity.		
Design: Well designed water harvesting and irrigation		
Construction: Sustainable construction material. High quality irrigation and drainage structures		
Implementation: The cooperative is dealing with the overall implementation activities		
O&M Farmers are participating to maintenance of infrastructures		
Beneficiary involvement: 80%		
Realization of benefits: Each household is getting an income of at least 200 000 RFW		
Other Remarks or observations: There is a need of monitoring the chemical water composition in order to get information on eventual toxic elements occurring in the dam.		
Contact person completing form: Dr Eng Naramabuye Francois, Cell 250 08874486		
Contact details: National University of Rwanda, P.O.Box 543 Butare-Rwanda		
Legend for Water harvesting schemes		
1. Open Pond – excavated in natural conditions		
2. Haffir/ crescent shaped dam/Water Ponds/Pans		
3. Small Dam - earth embankment		

4. Sub-Surface Dam		
5. Sand Dam		
6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. Insitu Water harvesting Measures/ Soil and Water Conservation techniques on arable rain fed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit
		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment

Date of Visit : 14 – 15 -16 November 2007.	Category:

Name of Site: **RUGERAMIGOZI marshland**, composed by:

RUGERAMIGOZI I
RUGERAMIGOZI II
BIRINGANYA

Sketch Map of Site

Geographic location of practice: : - South Central of Rwanda.
- Muhanga District.
- Nyamabuye sector RUGERAMIGOZI I
RUGERAMIGOZI I
-Gahogo Cell

(GPS) Coordinates: S 02o06'29.9'' and S02006'92.9''
E029o45'09.6''and E029045'09.6''

Description of the Community: Community surrounding Rugeramigozi marshland and people of Muhanga town.

The Rugeramigozi marshland community comprises 48 % of female and female are represented at all levels , but women and disadvantages groups are specially taken care. -Number of household: 3310, RUGERAMIGOZI I: 1060 farmers (56 associations)
RUGERAMIGOZI II: 1517 farmers (43associations)
BIRINGANYA :730 farmers (24 associations).

- Over all population: 11 276 habitants.

- Name of village: Between Shyogwe and Nyamabuye sectors.

Characteristics of the area: The Rugeramigozi marshland is located between hills. Its watershed is conserved from soil erosion using radical terracing. The German Agro Action an international NGO is supporting regional planning. The soils texture is mainly clay sand.
The Rugeramigozi I is only supplied in water by Rugeramigozi stream which is also used for drinking water after purification by Electoral (water and electricity supplier company) at Inhuman.
The system used is submersion irrigation.

Date of Visit 14 and 15th November 2007	Category:
Name of Site: RWASAVE 2	Either water Harvesting; Community Irrigation or Private Public Irrigation O
Geographic location of practice: The site is located in south province of Rwanda. Its borders lie between Mbazi, Ngoma and Kibirizi sectors of Huye District and reach Save sector of Gisagara District.	
(GPS) Coordinates: 1625 m of elevation, 2º40' south latitude and 29º45' east longitude.	
Description of the Community: (Including no of beneficiaries; gender groups; number of households; names of villages; overall population; etc The beneficiaries are the inhabitants of the sectors surrounded by the marshland. The number of household is arising around 1830 and over ¾ of the farmers are women. The overall population is 8215. The area is divided into three sites. The COAIRWA occupies the largest part of the marshland (87 %), the SPIR (research centre of the National University of Rwanda) exploits 10% and the rest is reserved to the CFJ (Centre de Formation de la Jeunesse).	
Characteristics of the area:	
Climate (AEZ) + Description: 19 °C 59 days dry	
Average annual rainfall (mm) 1298 mm	
Months of Short Rains: July-August	
Months of Main Rains:	September-December
Mean annual ref. crop Evapotranspiration (mm):	
Predominant soil type: , Vertisols	
Topography: Flat	
Slope:: 3%	
Erosion: No erosion	
Period of year during which used:	(from 15th january-june) and season B (from 15th august-december)

Period of year during which benefits utilised: July(season A) & February (season B)	
Water Source: Rwabuye stream	
Cultivated area: 18,5 ha of SPIR(Station Piscicole de Rwasave) 6,5 ha of CFJ (Centre de Formation de la Jeunesse) 127 ha of COAIRWA (Cooperative y'Abahinzi b'Igishanga cya Rwasave	
Technical Description: (Please describe in about 250 words the background of the practice, how it is used, details of how the site is used, its components, how it achieves its objectives and its main purpose - For example if it is used for drinking water, The SPIR uses 8,75 ha for fisheries research. Indeed the Rwasave Station is considered as the National reference for fisheries research. It is providing scientific support to all fish activities in the country. Two Ph.D project and a third one in progress has been carried out in the "Station Piscicole de Rwasave). The focus of the ongoing research aims to integrate fix production and rice cropping using nutrient rich water ponds as fertilizer for rice production. -Around 176 ha are covered by COAIRWA activities. Those activities are essentially focusing on rice cropping. The irrigation system used is basin irrigation. This is the most common type of surface irrigation and is particularly used in paddy rice production. Before adopting that basin irrigation	
Technical Details: (Describe the studies that were carried out before implementation, any design manuals or guidelines that were used for implementation, Relevant Reports and Design Data used in Designs, and any major calculations made including runoff, Obviously some studies on SPIR are available in The library of the National university of Rwanda (faculty of agriculture). Engineering studies could not be available because the SPIR was established before GENOCIDE and much report have been lost. The section of the marshland used by COIRWA was not subjected to a specific study. Normally, the users are applying their experience to manage the marshland for rice production.	
Useful in: Describe the types of area where it can be used, the conditions where it produces good results, Sites of applications, etc. The practice used by the	Limitations: Describe the conditions or situations where it does not perform well and conditions that will restrict its

cooperative could be extend to any other area where similar source of water could be available as well as similar topography and almost similar soil properties.	wider application: In case the source of water is not permanent, it would be hard to apply because the rice is harvested twice a year (2 seasons)
Geographical extent of use: The areas of the study country where it is found and the sort of areas where it could be used within the Nile Basin. The practice could be extended in Burundi in the central plateau AEZ	Effectiveness: (Describe whether it has achieved its objectives, how well it has done and the general strengths of the practice and whether it has in fact achieved what it set out to do. The practice has achieved its objective of increasing the population income and sustain population basic feeding. The research center had also achieved its objectives of extending results in the entire country where fish ponds are being carried out
Other Sites where used: Mumbai,	
Cost: (If possible, and applicable, please indicate the total budget for the best practice, the sources of funding, the implementation period, the total cost and cost per cubic meter of water stored or per ha irrigated, beneficiary contributions, etc.) For the best practice, the cost per hectare irrigated is estimated to 1 650 000 RWF. Then the total cost for 182 ha is 300 600 000 RWF. The main sources of funding are NGOs, State and beneficiary contributions. The period of implementation is divided into 3 phases. Each phase will take 15 months. The beneficiary's contributions are:	Operation and Maintenance arrangements: (Who manages, operates and maintains the works, how this is funded, contributions levied per user, percentage of payment received against amounts requested, any assistance and support received from Government or both Cooperative are maintaining the irrigation system themselves. For SPIR, The production of fish is enough to cover maintenance

Each household will contribute 2000 RWF per Low paid Manpower Protection of infrastructure, etc	activities
Benefits: (Estimate the returns achieved from the site if involves irrigation or costs saved in getting water if water for humans or livestock The rice yield per ha is estimated to 5 tones which generate 750 000 RWF considering 150 RWF per kg. The benefits are then 750 000 minus 200 000 for labor, fertilizers and seeds and cooperative annual fee) RWF. The benefits are therefore 550 000 per ha times 2 seasons = 1 100 000 per ha per year	Water User Association or User Group: (Provide details of the type of organization, how it works and elects members, number of members and all other pertinent details). For COIRWA cooperative, the executive committee is directly elected by cooperative members for a period of one year renewable many times, The main tasks of the cooperative executive committee are to organize the farmers in all concerns, legal representation of the farmers, training organization, market search and price bargaining.
Stakeholders and beneficiaries: (Who are the main initiators: Farmers, actors: RSSP, local government, cooperative, stakeholders: RSSP, local government, farmers cooperative, beneficiaries and users: Farmers. How and why are they involved in the practice? Farmers were involved at the beginning because they are the initiators and have been also involved in the technical rehabilitation of the marshland	Enabling Environment: (Policies, design standards and manuals that made the concept possible, where the community obtained the idea, was it demand based or introduced by Government or private sector initiatives, etc.). After farmers have initiated preliminary marshland management, the local government fell concerned to improve the technical level of management and ensuring the environmental protection. The law on

Who are the main beneficiaries	Environment protection is clear on marshlands use. beneficiary involvement demand based interventions
Training support: (Details of any training carried out before, during and after construction and how the community has benefited from this). RSS farmers (Rural Sector Support) organizes training for farmers in different areas such as agricultural practices	Extension support: (Details of any extension services provided and whether any help is given in assessing annual O&M needs and preparing costs and how the community has benefited from this). The RSSP was involved in helping the farmers to manage efficiently the ,marshland and had organized some training
Environment benefits: (Whether it has been completed as part of part of watershed development or integrated management approach, how it fits in, visible benefits achieved in terms or water availability, reduction in erosion, vegetative growth etc). Visible benefits were achieved through integrated management approach are erosion reduction by trees plantation up hills, water availability by using the canal systems down hills. Sustainability economic aspects cultural environmental aspects technical	Social/Cultural acceptability: The use of marshlands for crop production is traditionally practiced during dry season. The rice cropping is quite old in the country. It started near 1970s and had became socio-culturally accepted by the farmers since it improves the life standard of rural population

Advantages: (Strengths of the approach adopted, how well it fits into the community and meets its needs, is it affordable and reliable, will the community continue to operate, maintain and use it after outside assistance has gone and reasons for this et The RSSP thought EMUGECO construction company is installing some components which will help the best use of the marshland. Farmer's activities generate income thereby leading to fit their needs. The work in association allows confirming that the system will continue to operate after RSSP support..	Disadvantages: (Constraints that restrict its effectiveness, the risks involved in its developments, the conditions under which it will not work or have reduced impact etc.). No DISADVANTAGES
Scaling Up: (Are there specific conditions or obstacles which make it impossible to replicate or transfer the practice elsewhere - e.g., a specific climate or specific cultural beliefs or social relations which are important for the success of this practice. No significant obstacle	What is potential for applying all/parts of initiative elsewhere?
	(Score from 1 to 10 on list below with 10 being highly applicable)
	I [ ] Transfer of practice to another group/culture/land-use system, etc. 7
	II [ ] Easy to transfer the practice, but with minor adaptations for local conditions 8
	III [ ] Transfer possible, but significant modifications/prerequisites to consider. 6
	IV [ ] Difficult to transfer the practice. Need experienced support.4
	V [ ] It would be impossible to transfer the practice. Too site specific. 1
	Other specific remarks: (e.g., agreements, regulations, provisions

	regarding Intellectual Property Rights, etc.) All policy and legal framework both for land and environment management are available

Best Practices: (Why this site/ case is considered to be a successful best practice; express this success in qualitative or quantitative terms; whether all or only part of the practices of the site can be considered best Practice - name them and give reason The site is considered to be a successful best practice because that practice is generally associated with low energy costs. Some of the major advantages are that they are easy to operate and maintain with skilled labor and they are not affected by wind conditions .Moreover, they are good for leaching of salts from the root zone.

Contact Organization: (For further information; site visits' etc)

Type of organization:	Contact person:
[ ] government organization: SPIR and	Contact details 1. NIYIBIZI Léon Sector: Save, District: Huye, Southern province
[Community : COAURWA	
[ ]	
[	
[	

Lessons learnt: (at various stages of the realization of the works, describe any lessons learnt that would improve upon future similar interventions)

Planning: Before the project starts, the RSSP made sure to plan the whole batch of activities by involving the farmers

Design: The design of the overall field was simple and efficient. The distribution of water was also simple and technically efficient

Construction: - The building materials are supplied from a nearby site. The material used were good enough to allow a sustainability of structures

Implementation: The overall planning is implemented and monitored periodically

O&M Operation and maintenance

Beneficiary involvement: Beneficiaries are fully involved in planning, infrastructure maintenance,

Realization of benefits: Such as markets; achieving better returns - crop selection &/or market

linkages etc).
Other Remarks or observations: MM. N. Luginbühl et J-C. Micha, c. F. (1999). Plan Directeur de Développement des Pêches et de l'Aquaculture. Pêche et Aquaculture au Rwanda: revue sectorielle. l. p. p. l. D. d. l. P. a. l. K. R. e. l. p. R. p. l. P. d. En collaboration avec la Division Pêche et Aquaculture. Rwanda PROGRAMME DE COOPERATION TECHNIQUE.
Contact person completing form:
Dr Eng Naramabuye Francois, E: naramabuye@yahoo.fr. Rwanda,

E:		
1. Open Pond - excavated in natural conditions		
2. Haffir/ crescent shaped dam/Water Ponds/Pans		
3. Small Dam - earth embankment		
4. Sub-Surface Dam		
5. Sand Dam		
6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. Insitu Water harvesting Measures/ Soil and Water Conservation techniques on arable rain fed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit
		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment

Date of Visit : 12th November 2007	Category: Farmer's cooperative of UCORIBU, with his representative RWAGASANA Joseph (President), is in partnership with the local government of GISAGARA District.
Name of Site: **CYILI-MAYAGA**	
Geographic location of practice: The site of CYILI is located in Southern Province, GISAGARA District, sectors of GIKONKO (Cyili and Mbogo cells), MUSHA (Bukinanyana and Gatovu cells) and MAMBA (Mamba and Ramba cells),	
(GPS) Coordinates: Latitude 20 30 South and Longitude of 30^0 East	
Description of the Community: The site of Cyili is managed by a farmers cooperative union named UCORIBU which is made of 7 cooperatives. The members of the community are small scale farmers. The number of beneficiaries of the Gisagara Rice site is estimated to 20,560 people (representing approximately 5140 families). Among them, at least 10,000 are women. The members are distributed in 6 cells (CYILI, MBOGO, BUKINANYANA, GATOVU, MAMBA and RAMBA). The overall population of the concerned sectors is estimated to 80. 546 people	
Characteristics of the area: The characteristic of GIKONKO area is Agricultural area. The climate is characterized as a semi arid-climate.	
Climate (AEZ) + Description:	
Average annual rainfall (mm) 1298 mm: The average annual Rainfall GIKONKO area is 1000mm	
Months of Short Rains: September-December	
Months of Main Rains: The main rainy season is from February to May. In general, the GIKONKO rice site has a good distribution of rainfall. In April, strong rainfall can	

cause temporally a sub mention of wetland		
Mean annual ref. crop Evapotranspiration (mm): Normally, the stable temperature of the area is between 27 and 29°c and the minimum stable temperature is between 12 and 13°c.The solar radiation is between 155 to 227hours par month.	: Normally, the stable temperature of the area is between 27 and 29°c and the minimum stable temperature is between 12 and 13°c.The solar radiation is between 155 to 227hours par month.	
Predominant soil type: The predominant soil of Gikonko wetland is characterized by a mineral soil which is composed by clayey soil, loamy clay, and hydromorphy soil. The wetland borders are characterized by the accumulation of sand which means that, this soil is sandy. In the middle of the wetland, organic soil is observed. The pH unused water of the wetland varies between 4 and 6. -		
Topography: The altitude of GIKONKO wetland Site is 1400 and 1500m, the hill side varies between 1500m and 1800m. The wetland slopes are also observed during survey carried out before and are between 5 and 1 %. The valley is like an open U. ___		
Slope: The hill side slope is estimated to 30- 40%		
Erosion: The erosion is due first to an uncovered surface area and the topography, secondary is due to the texture which is characterized by a sandy texture, and third, the presence of low organic carbon(less than 2%).		
Period of year during which used: In Cyili wetland, rice agricultural practices is done only in one season because, of lack of water in dry season, so rice is cultivated in only one agricultural season from January to Jun. And in the second season, farmers cultivate Maize's, and other crops which can tolerate the dry season		
Period of year during which benefits utilised: July(season A) & February (season B)		
Water Source: In GIKONKO Rice site, many sources supplies water in the wetland: ▪ starting by the sub site of CYILI wetland, many sources are observed: - KABIKONO		

- NYARWAMBU
- RWASANZU
- MUSHADUKA
- MWURA;

▪ About the sub site of NGIDYI, we have also many sources which are:

- MUKANDE
- NYERANZI
- MUYAGA
- KIGARAMA

.

Cultivated area: The cultivated area of Gikonko site is estimated at 1000ha

Technical Description: i) CYILI sub site: The site of CYILI is irrigated by one principal channel accompanied by one paralleled secondary channel. In that site, water is distributed by gravity from the secondary channel to the entire field. Unused water is carried within a drain channel which draining straight into Akanyaru river (Akabgera-1). Water distribution infrastructures are available from the secondary channel, and those infrastructures are built in sustainable materials (Stones and cement). A portion of the wetland (MUSHADUKA branch, MWURA, branch) field is irrigated from both sites of wetland and two irrigation principal channels are distributing water from each of the wetland by gravity. Unused water is drained from both sites into a principal middle draining channel, and then after the draining channel is collecting water towards Akanyaru River (Akagera-1).

ii) NYIRAMAGENI sub site: The system of water distribution is exactly the same as the MUSHADUKA branch and MWURA branch of CYILI sub site.

Technical Details: Technical details are characterized as water harvesting, small dams construction or small infrastructures which alarm the storage of water.

Useful in:	Limitations:
Wetland is used in producing rice in general, but during in dry period, due to a lack of water, the wetland is used in producing maize and potatoes at small extend.	

Geographical extent of use: As explained by the Vice mayor in charge of Economics affairs, one of the factory worker and the President of UCORIBU, the project can be extended to MIRAYI wetland located in GISHUBI and MUGANZA sectors, the whole AKANYARU wetland located in MUGANZA and MUKINDO sectors, KABOGOBOGO wetland located in KIGEMBE and KANSI sectors, AKABOTI in KANSI sectors, RWASAVE in SAVE and KIBIRIZI sectors, DUWANI in KIBIRIZI sector. Other Sites where used:	Effectiveness:
Cost: The cost of CYILI sub-site is estimated to 1,500,000,000 Few; and the cost of NGIDYI – MYIRAMAGENI sub site is estimated to 1,500,000,000 Few	Operation and Maintenance arrangements:
Benefits: The cost production is 2,000,000,000 Few The production is estimated to 20000 Tons/Year This production is equivalent to 3,000,000,000 Few Benefit = Production – Production cost = 3,000,000,000 – 2,000,000,000 = 1,000,000,000 Few Benefit income to household = 1,000,000,000 / 5140 = 194552, 5 Few The equivalent of income to household is about 195,000 Few Year	Water User Association or User Group:
Stakeholders and beneficiaries: ▪ Stakeholders Local government of GISAGARA District Farmers Cooperatives Businessmen	Enabling Environment:

National University of Rwanda (FACAGRO, GRAD) - Live stock farmers Construction Businesses ▪ Beneficiaries Local government (Taxes) Farmers cooperatives Livestock farmers Agro business men ▪ Level of involvement: Local government: Technical support Collecting Taxes Renting parcels ¬ Cooperatives farmers : - Cultivation Harvesting Selling Businessmen: Transport Commercialization Factory : - Adding value _ Who are the main beneficiaries	beneficiary involvement demand based interventions
Training support: The training supports are done by: National University of Rwanda Faculty of Agriculture Public Administration Faculty of low MINAGRI RADA	Extension support:

MINITERE	
Environment benefits: The use of rice residues for bricks cooking constructing materials is an important thing in environmental management; it is also used in domestic cooking fuel material. Animals feeding using factory sub-product, his will reduce grazing areas which leads land degradation. The production of organic manure will help to increase soil carbon content and hence increase soil water holding capacity, this will reduce erosion and then increase periodicity. This practice will contribute to carbon sequestration: The increase of rice yield will decrease the surface areas used on hillside for agricultural production. Tree can be planted on hill side and increase atmospheric co2 absorption. Sustainability economic aspects cultural environmental aspects technical	Social/Cultural acceptability: The acceptability is 100% The have More than 40 years of experience of rice production, and the production is consumed in Rural and Urban areas
Advantages: Capacity of maintenance; 1Kg of paddy rice cost 150Frw 100 Frw is spent in maintenance, infrastructure, cultivation, fertilizers. So, the system is sustainable because it can cause the income to the population up to 195,000 Frw/ family/ Year (net Income)	Disadvantages: Activity coordination (MINAGRI,RADA, Local government, Donors, ISAR, National University of Rwanda). Basic infrastructures need to be rehabilitee (roads, communication,) –
Scaling Up: All requirements are available (Technical support, legal framework, environmental protection, policy)	What is potential for applying all/parts of initiative elsewhere? ▪ Transfer of practice to another group/culture/land-use system, etc. (8)

	▪ Easy to transfer the practice, but with minor adaptations for local conditions (6)
	▪ Transfer possible, but significant modifications/prerequisites to consider (7)
	▪ Difficult to transfer the practice. Need experienced support. (2)
	▪It would be impossible to transfer the practice. Too site specific (0).
	Other specific remarks:

Best Practices: i) Water catchment:

Although the project does not manage to provide enough water for two seasons cultivation, the source of water is sustainable and technology used for catchment is professionals

ii) Distribution of water: This step is well organized because it uses sustainable infrastructures such as distribution channels (principal, secondary) Water outlet infrastructure are also well organized.

iii) Family organization: 9 Cooperatives united in one major Cooperative named UCORIBU (Union of Rice Growers Cooperative of Butare).

The importance of this organization is connecting organizing individual farmers for common services (Technical, Administrative).To form legal representative of all rice growers, and organizing training, fertilizers, markets.

iv) Factory: The factory is closed to the rice growers they can sell immediately after harvesting (avoiding storage risks).

Factory constructs their own harvesting infrastructures (stores, drying areas)

Contact Organization:		
Type of organisation: Partnership - Public and Community - Farmers	Contact person: Public	
	Contact details : HATEGEKIMANA Helson (Vice mayor in charge of economic affaires in	

	GISAGARA District) P.BOX 219 BUTARE Cell phone: 08484858 Email:

Lessons learnt: ▪ Planning: 70%

- ▪ Design: 80%
- ▪ Construction: 70%
- ▪ Implementation: 50%
- ▪ O&M:
- ▪ Beneficiary involvement: 90%
- ▪ Realizations of benefits: 50%
- ▪ Other Remarks or Observations

We have to focus to water harvesting and storage due to uncertain rainfall regimes

Planning:
Design:
Construction:
Implementation :
O&M :
Beneficiary involvement :
Realization of benefits:
Other Remarks or observations:
Contact person completing form: Dr Ir. NARAMABUYE F. Xavier
Contact details: Lecturer at National University of Rwanda Faculty of Agriculture Department of Soil science and Environmental Management P. Box: 117 Cell: 08874486

Email:		
Legend for Water harvesting schemes		
1. Open Pond - excavated in natural conditions		
2. Haffir/ crescent shaped dam/Water Ponds/Pans		
3. Small Dam - earth embankment		
4. Sub-Surface Dam		
5. Sand Dam		
6. Well - shallow hand dug - with SSI		
7. Well - Deep hand dug - with SSI		
8. Spring Development for SSI and/or other uses		
9. Roof Water Harvesting (Domestic Use)		
10. Runoff Water Harvesting (Domestic Use)		
11. Runoff Water Harvesting (Agricultural/Homestead Use)		
12. Rock and other surface catchment systems		
13. River water harvesting (diversions) for small scale irrigation		
14. Spate Irrigation		
15. Recharge Structures		
16. Insitu Water harvesting Measures/ Soil and Water Conservation techniques on arable rain fed lands		a. Conservation tillage
		b. Planting Pits
		c. Katumani Pit
		d. Semi-Circular Bunds
		e. Negarim
		f. Tied Contour ridges
		g. Contour Stone Bunds
		h. Fanya Juu
		i. Earth Bunds with external catchment
		j. Contour ridges with external catchment

Date of Visit: 20th November 2007	Category:
Name of Site: **BUGARAMA**	Farmer's cooperative of C.P.R.B, with his representative AYABAGABO Léopold (President), is in partnership with the local government of RUSIZI District.
	Sketch Map of Site (See Report full 10)
Geographic location of practice: The site of BUGARAMA is located in Western Province, RUSIZI District, in BUGARAMA sector (in Nyange, Pera cells),Muganza sector in Cyarukara, Gakoni,Shara cells)and Gikundamvura sector in Kizura and NYAKABUYE sector (in NYAMARONKO and KIZIHO cells)	
(GPS) Coordinates:	
Description of the Community: The site of BUGARAMA Rice is a public community managed irrigation. The number of beneficiaries the BUGARAMA Rice site is equivalent of 7.862 people .Among them, at least 3.450 are female. The number of house holds is estimated to 1310. sectors covered are Bugarama,Muganza,Gikundamvura,,and Nyakabuye in general the overall population of the area is estimated to 66.320.	
Characteristics of the area: Bugarama is an Agricultural area. Characterized by fertile soils.	
Climate (AEZ) + Description: Imbo AEZ characterized high temperatures and 1200 mm rainfall	
Average annual rainfall (mm): The average annual Rainfall BUGARAMA area is1200mm..	
Months of Short Rains: The small rainy season is carried out from September-December	

Months of Main Rains: The main rainy season is from February to May. In general, the BUGARAMA site has a good distribution of rainfall. In April, high rainfall can cause temporally floods The variation of rainfall is about 55% between July and August and 90% between March and May.
Mean annual ref. crop Evapotranspiration (mm):
Predominant soil type: Vertisols are predominating the middle of the marshland while some Andisols are also observed between hillsides and marshland, The texture tend to be clay in the middle and sandy loam in the at the external part of the marshland The pHwater ranges between 5.4 and 7
Topography: The altitude of BUGARAMA wetland Site is 900 and 950 m the hill side varies between 1.000and 1200m. The wetland slopes are also observed during survey carried out before and are between 2 and 5 %. The fields are broadly plans.
Slope:
Erosion: Could be observed on the hillside due to a combination of the following factors: The erosion is firstly due to an uncovered surface area, the sandy texture the low organic carbon (less than 2%) and human activities.
Period of year during which used: In Bugarama wetland, rice agricultural practices is done only in two seasons because ,of irrigation practices. so rice is cultivated in two agricultural seasons from December to May season A and from June to December season B .
Period of year during which benefits utilised: The benefits are observed after harvesting and selling the yield to the factory in June and December.
Water Source: In Bugarama Rice site, is supplied in water by many sources as it can be observed on the map appendix 3

<table>
<tr><td colspan="2">These include"
- RUBYIRO
- NJAMBWE
- KATABUVUGA
- In north and center
South Bugarama is supplied by:
- RUNGUNGA
- CYARUKARA
- CYAGARA</td></tr>
<tr><td>Cultivated area: The cultivated area of Bugarama site is estimated to 1650ha</td><td></td></tr>
<tr><td colspan="2">Technical Description: BUGARAMA site: The site of Bugarama irrigated by one principal channel branched of secondary channels In that site, water is distributed by gravity from the secondary channel to the entire field. Unused water is carried within a drain channel which is draining straight into RUBYIRO river . Water distribution infrastructures are available from the water caption dam ,secondary channel, and those infrastructures are built in sustainable materials (Stones and cement) and reinforced concrete cement . A portion ,of the wetland (CYAMURA branch ,KIZURA branch) field is irrigated from both sites into a principal middle draining channel, and then after the draining channel, the water is collected towards RUSIZI</td></tr>
<tr><td colspan="2">Technical Details: Technical details are characterized by a professional water caption structure as well as water distribution. See photos</td></tr>
<tr><td>Useful in: Marshland is used in producing rice in general, but during in dry period, due to a decrease in water availability, the marshland is also used for producing maize and vegetable at small extend.</td><td>Limitations: no storage measures due to lack of dams and other specific infrastructures for water storage which allow the decrease of
rice production in dry season</td></tr>
<tr><td>Geographical extent of use: As explained by the Managing Director in 2006 supported by R.S.S.P we have extended 410</td><td>Effectiveness: Highly effective</td></tr>
</table>

ha in Est and North Bugarama and it still possible to extend to the north and East	
Other Sites where used: A construction of a dam for water storage could allow cultivation of rice in other site surrounding the area already cultivated	
Cost: The cost of Bugarama -site is estimated to 4.500.000.000 Frw; and the cost of NYAKABUYE Kizura sub site is estimated to2.500.000.000 Frw.	Operation and Maintenance arrangements: The farmers mobilize money periodically to deal with maintenance activities. Central government is also supporting farmers initiative
Benefits: The cost production is 2,000,000,000 Frw The production is estimated to 18.500. tones/year This production is equivalent to 3,700,000,000 Frw Benefit = Sells – Production cost = 3,700,000,000 – 2,000,000,000 = 1,700,000,000 Frw Benefit income to household = 1,700,000,000 /1310 = 129 770,0 Frw The equivalent of income to household is about 129.770 Frw/ Year.	Water User Association or User Group: Water used by Farmers cooperatives
Stakeholders and beneficiaries: ▪ Stakeholders Local government of RUSIZI District Farmers Cooperatives Businessmen - Live stock farmers Construction companies ▪ Beneficiaries Local government (Taxes) Farmers cooperatives	Enabling Environment:

Livestock farmers Agro business men ▪ Level of involvement: Local government: Technical support Collecting Taxes ¬ Cooperatives (farmers) : - Cultivation Harvesting Selling Businessmen: Transport Commercialization Factory : - Adding value Who are the main beneficiaries	beneficiary involvement demand based interventions
Training support: The training supports are done by: MINAGRI RADA MINITERE -ROPARWA - Imbaraga Syndicate	Extension support: The training supports are done by: MINAGRI RADA MINITERE -ROPARWA - Imbaraga Syndicate
Environment benefits: The use of rice residues for bricks cooking constructing materials is an important thing in	Social/Cultural acceptability: The acceptability is 100%

Environmental management; it is also used in domestic cooking fuel material. Animals feeding using factory sub-product, his will reduce grazing areas which leads land Degradation. The production of organic manure will help to increase soil carbon content and hence increase soil water holding capacity; this will reduce erosion and then increase periodicity. This practice will contribute to carbon sequestration: The increase of rice yield will decrease the surface areas used on hillside for agricultural production. Tree can be planted on hill side and increase atmospheric co2 absorption Sustainability economic aspects cultural environmental aspects technical	They have More than 30 years of experience of rice production, and the production is consumed in Rural and Kigali town.
Advantages: Capacity of maintenance; 1Kg of paddy rice cost 200Frw 120 Frw is spent in maintenance, infrastructure, cultivation, fertilizers. So, the system is sustainable because it can cause the income to the population up to 129.770 Frw/ family/ Year (net Income)	Disadvantages: General decrease in water budget due oxidation of organic matter
Scaling Up: All requirements are available (Technical support, legal framework, environmental protection, Policy)	What is potential for applying all/parts of initiative elsewhere? ▪ Transfer of practice to another group/culture/land-use system, etc.

	(7)
	▪ Easy to transfer the practice, but with minor adaptations for local conditions (8)
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	▪ Difficult to transfer the practice. Need experienced support. (5)
	▪It would be impossible to transfer the practice. Too site specific (1).
	Other specific remarks:

Best Practices: i) Water catchments:

Although the project does not manage to provide enough water for two seasons Cultivation, the source of water is sustainable and technology used for catchments is Professionals

ii) Distribution of water: This step is well organized because it uses sustainable Infrastructures such as distribution channels (principal, secondary) Water outlet Infrastructure are also well organized.

iii) Family organization: 7 Cooperatives united in one major Cooperative named UCORIKI (Union of Rice Growers Cooperative of KIVU).But C.P.R.B is major cooperative up to now.

iv) The importance of this organization is connecting organizing individual farmers for common services (Technical, Administrative).To form legal representative of all rice growers, and organizing training, fertilizers, markets.

v) Factory: The factory is operational to the rice growers they can sell immediately after Harvesting infrastructures (stores

Contact Organization:		
Type of organization: Partnership	Contact person: Public	

- Public and Community - Farmers	
	Contact details: Eng RUSHIGAJIKI Egide Managing Director of Bugarama Rice Plantation cooperative P.BOX 101 RUSIZI Cell phone: 55104456 /08582728 Email: rugide 2007@ yahoo.fr
Lessons learnt:	
Many lessons were learnt im all the following areas. Bugarama is one of the better marshland site well organized and managed	
Planning:	
Design	
Construction	
Implementation	
O&M	
Beneficiary involvement	
Realization of benefits:	
Other Remarks or observations:	
Contact person completing form:	
Contact details	
Legend for Water harvesting schemes	
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