

Protocols for CATALIST 2010 A Season Demonstration Trials

Introduction

CATALIST efforts to promote agricultural intensification focuses on moving farmers from subsistence to market oriented production through the use of integrated soil fertility management practices that incorporate the recycling of crop residues, use of composted manures and proper use of external inputs including commercial fertilizers, improved seeds and pesticides and herbicides. For the past 2.5 years, CATALIST has promoted the use of these improved technologies with positive results. Based on these results, for the remaining 4 seasons (2010 and 2011 Seasons A&B), CATALIST must focus on convincing as many farmers as possible of the economic benefits of using external inputs. CATALIST will make a serious effort to conduct demonstrations throughout the project's region of focus in this coming season as well as in the future. These demonstration trials will illustrate technology packages that promote intensification and position the farmer to move from subsistence production to surplus production of crops identified as feasible for value chain development.

For 2010 Season A, 44 value chains have been identified in Burundi, DRC Kivu and Rwanda. Contracts with facilitators for each of these value chains have been developed and distributed. In order to successfully conduct the demonstrations, input from the value chain facilitators has been solicited to the extent possible. On the following pages you find the general recommendations for the identified value chains in each country followed by technical sheets for establishing the CATALIST demonstration trials for each crop. CATALIST anticipates changes to these technical recommendations that for the following seasons, especially for the new crops (e.g. pineapple, passion fruit, vegetables, etc.) based on improved knowledge to be generated over the next 2 years. CATALIST also anticipates increased accessibility to additional fertilizer products (e.g. calcium ammonium nitrate [CAN], TSP, Minjingu phosphate rock [MPR]) and testing of other improved varieties for wheat, maize and rice.

BURUNDI

1. Project: CATALIST
2. Objective: Promote market oriented production in the focus regions of Burundi based on a comparison of farmers' practice to CATALIST best bet technologies and recommendations. These technologies and recommendations are expected to result in maximum economic yields for the producer.
3. Crop-Locations:

Riz (rice irrigated)	- Mutimbuzi Buja Rural -Muramba-Kirundo -Bwambarangwe -Rugombo-Cibitoki -Ngozi -Mutimbuzi
Tomate-aubergine (tomato-eggplant)	-peri urban Bujumbura rural
Pomme de terre (potatoes)	-Mugongomanga-Buja Rural - Kabarore-Kayanza
Blé (wheat)	-Muramvya
Legumes (vegetables)	-Bukeye-Muramvya
Maracuja (passion fruit)	- Matongo-K Matongo--- Kayanza
Haricot (green beans)	- Gashikanwa-Ngozi
Fourrage legumineuses (legume forages)	-Ngozi
Fourrage graminee (grass forages)	-Ngozi
Patchouli (essential oil)	-Rugombo
Manioc (cassava)	-Kayogoro

4. Design: The demonstration trial for each group of farmers/producers will consist of two plots (treatments) for comparison. Plot 1 will be the farmer's normal practice and will vary by farmer. For example, if the farmer normally uses composted manure and saved seed then this plot will be planted using only composted manure and saved seed. If the farmer typically uses some fertilizer (e.g. potato farmers) in addition to composted manure¹, then the plot will include fertilizer. Plot 2 will be planted based on CATALIST recommendations for each crop including inputs ((fertilizers, improved seed, integrated soil fertility management [ISFM] strategies (crop residues, composted manures, and possibly lime depending on soil pH and crop requirements)) at recommended application

¹ Composted manure only—no fresh manure should be used.

rates. Plot 2 should always include incorporation/recirculation of any cereal straw or leguminous leafage not used for animal feed. Plot 2 will also be managed carefully to prevent pest and disease and may require the use of pesticides. Other maintenance activities such as weed control and irrigation for paddy rice should be done in both plots. Plots 1 and 2 should be located side by side (on sloping ground the 2 plots will be arranged on the same contour perpendicular to direction of the slope) with a sufficient grass strip/distance between the plots to reduce pesticide drift or nutrient runoff. For the irrigated rice plots, bunds will have to be of sufficient height and strength to prevent the exchange of floodwater between the two plots for the entire season.

Below in Table 1 is the application rate for fertilizers and other inputs (composted manure and lime) specific to the plot size (1, 2.5 or 5 [cassava/manioc only] ares) required for Plot 2 for each crop. Table 2 contains information on plant spacing, number of demonstrations, total area and quantity of seed required for the crops in each commodity value chain. Table 3 contains information on the varieties proposed for use in the demonstration trials for plot 2 which represents our best technology package at this point and time. For future demonstration trials, CATALIST will work to identify additional new varieties (not currently available in the region, but commercially available) that produce better quality crops, higher resistance to disease and insects, and/or shorter duration growing cycles.

Table 1. CATALIST Recommendations for Fertilizer and ISFM Inputs for Plot 2-Burundi.

Crop/Culture	Plot Size/ Superficie de la parcelle élémentaire (en ares)	Fertilizer Application Rate/ Dose d'engrais (kg/ha)			Fertilizer Rate per plot/Quantité pour la parcelle avec engrais (en kg)			ISFM ^b Inputs/Autres intrants pour 1 parcelles
		Urée	DAP	KCl	Urée	DAP	KCl	
Rice/Riz	2.5	150	100		3.75	2.5		-----
Tomato/Eggplant ^a Tomate/aubergine	1	120	40	30	1.2	0.4	0.3	Composted manure and 50 kg dolomite pH<5.5
Potato/Pomme de terre	2.5	140	80	60	3.5	2	1.5	Composted manure and 100 kg dolomite pH<5.0
Wheat/Blé	2.5	100	100		2.5	2.5		Composted manure and 75 kg de dolomite if pH<5.5
Vegetables/Légumes	1	120	40	30	1.2	0.4	0.3	Composted manure and 50-75 kg dolomite pH<5.5
Passion Fruit/Maracuja	1	70	40	30	0.7	0.4	0.3	Composted manure and 25 kg dolomite if pH<5.0
Green Beans/Haricot ^c	2.5		50			1.25		Composted manure and 50 kg de dolomite if pH <5.0
Legume Forage/Fourrage- légumineuses	2.5		50			1.25		-----
Grass Forage/Fourrage- graminée	2.5	40	40	30	1	1	0.75	-----
Patchouli	2.5	120	40	30	3	1	0.75	Composted manure
Cassava/Manioc	5.0	40	80	60	2	4	3	-----

^a Possibility of secondary or micronutrient deficiencies exist with tomato. Additional fertilizer sources have been identified.

^b Available crop residues (cereal straw or leguminous leafage) should always be incorporated into field when not used for fodder. In addition, composted manure is recommended for most crops. Lime is recommended for acidic soils once the pH drops to a level that would inhibit crop response to fertilizers.

^c Higher P rate will be required for volcanic soils (80 kg/ha) . TSP fertilizer (if available) may be economically more feasible than DAP.

5. Monitoring and Evaluation: In order to properly maintain the demonstrations and to promote facilitators' oversight a timeframe for implementation of activities associated with establishment and maintenance of the demonstration plot will be required. In addition, there will be common measurements and activities required for each plot in each demonstration including:

- Planting date (should be the same for Plots 1&2)
- Germination date
- Plant survival rate

- Maintenance (e.g. weeding, irrigation) dates
 - Pesticide treatment (dates) for insects or disease treatments (Plot 2 only) as needed. Plots should be checked at least twice weekly for insects and disease
 - Field days for neighboring farmers and number of participants
 - Yield sampling
6. Cultivation details by crop for **PLOT 2** can be found in Annex 1. Plot 1 of the demonstration will be the farmer's practice.

Table 2. Planting density and quantities of seeds required in Burundi

Crops	Planting density	Number of demonstrations	Total area Plots 1&2 (ares)	Quantity of seeds
Rice/Riz	20 cm x 20 cm	16	80	32 kg
Tomatoes /Tomate	80 cm x 80 cm	6	12	0.055 kg ^a
Eggplants/Aubergine	50 cm x 75 cm	5	10	0.050 kg ^a
Potatoes /Pomme de terre	80 cm x 50 cm	7	35	875 kg ^b
Wheat /Blé	120 kg/ha , 20 cm x 20 cm between rows	27	135	170 kg
Vegetables/Legumes				
Fresh green peas/Pois petit	40 cm x 20 cm	6	30	25 kg
Strawberry/Fraise	60-75cm x 45 cm	5	10	4000 plants
Onion/Oignon	30 cm x 15 cm	5	10	0.050 kg ^a
Passion Fruit/Maracuja	1.8 m x 3 m ^c	4	8	80 cuttings
Beans/Haricot	40 cm x 20 cm	2	10	10 kg
Legume forage/Fourrage-legumineuses	1 m x 1 m	1	5	500 seedlings
Grass forage/Fourrage-traminée	50 cm x 1 m	1	5	1000 stumps
Patchouli	60 cm x 60 cm	2	10	8500 cuttings
Cassava/Manioc	1 m x 1m	3	30	3000 cuttings

^a Seeds or seedling/transplant—seedlings preferable if available. Tomato seed will have to be purchased in Rwanda.

^b ISABU has indicated a possible shortage of seed potato—some quantities may have to be purchased in Rwanda.

^c Confirm cuttings required based on this spacing.

Table 3. Proposed Sites, Varieties, Altitude, and Rainfall for Value Chains-Burundi

Crops	Sites	Variety	Altitude (m)	Rainfall (mm)
Rice/Riz	Kirundo	V254-2-7	1350	1045
	Ngozi	V46	1600	1116
	Mutimbuzi	V18	850	771
	Cibitoke	WAT	900	800
Tomatoes ^a /Tomaté	Cibitoke	ROMA, ANA	900	800
	Mutimbuzi	Caraïbo type	850	771
Eggplants/Aubergine	Mutimbuzi	Tengeru white	850	771
Potatoes ^b /Pomme de terre	Kayanza	Ndinamagara	1900-2000	1463
	Mugongomanga	Ndinamagara Ingabire	2200	1386
Wheat/Blé	Muramvya	Mbayuwayo	1995	1386
Vegetables/Legumes				
Fresh green peas/Petit pois	Bugarama	MASHIGIHS A	1860-1995	1386
Strawberry/Fraise	Bugarama	SEKOYA	1860-1995	1386
Onion/Oignon	Bugarama	Red Onion	1860-1995	1386
Passion Fruit/Maracuja	Kayanza	Not known	1900-2000	1463
Beans/Haricot	Ngozi	AND 10	1600	1116

		G13607		
Legume forage/Fourrage légumineuses	Ngozi	Calliandra calothyrsus	1600	1116
Grass forage/Fourrage graminée	Ngozi	Tripsacum laxum	1600	1116
Patchouli	Cibitoke	Pogostemone cablin	900	800
Cassava/Manioc	Makamba	ABEY-IFE MM967204	1450	1219

ANNEX 1.
BURUNDI CATALIST DEMONSTRATIONS PLOT 2

Irrigated Rice/Riz (Burundi)

Important considerations in selecting field sites

- Optimal air temperature for irrigated rice is 20-38° C with optimal floodwater temperature between 21-29° C
- Floodwater is required in large quantities at 3-7 days following transplanting and the period between booting to 14 days after heading. Drain fields 10 days before harvesting so to dry soil and hasten drying and ripening of rice grains.
- Rotation of irrigated rice with soybeans and green manures during the off season provides benefits for maintaining soil fertility and soil structure and reducing the need for fertilizer nitrogen (N) for the next rice crop.

1. Seedling and Land Preparation and Fertilization

Nursery seedlings—prepare and flood the seedbed 2 weeks prior to sowing. Puddle one week before sowing and prepare a raised nursery bed. Drain the nursery bed the day before sowing. Broadcast between 500-1000 grains/are (seed rate equivalent to 50 kg/ha) onto the seedbed. Keep seed bed moist. Once seedlings emerge flood the seedbed to a depth of 1-3 cm depending on the growth of the seedlings. Allow seedling to grow for 14-18 days. One day prior to transplanting, raise the floodwater level to 10 cm to ease uprooting of seedlings.

Land Preparation--incorporate crop residues prior to puddling (one day prior to transplanting) and basal fertilizer application. Consideration should also be given to incorporating composted manure (if available) into paddy fields along with crop residues.

Basal Fertilizer Application—Before transplanting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (1.0 kg/are or 2.5 kg/plot), then level the soil before transplanting the rice seedlings. Flood the established trial with 10-15 cm of water.

Top Dressing--Urea (1.5 kg/are or 3.75 kg/plot) is split applied in two equal applications at the first weeding and just before panicle initiation (35-50 days after transplanting). Remove floodwater from the field prior to urea topdressing then re-flood.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety— V254-2-7 (Kirundo); V46 (Ngozi); V18 (Mutimbuzi); WAT (Cibitoke)
- Planting density—14-18 day old seedlings will be line transplanted in hills with row and plant spacing of 20 cm x 20 cm. Each hill will have 2 seedlings

- Other cultural practices: control weeds and floodwater on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Certified seed and resistant seed can help control diseases. Control insects and diseases on Plot 2 only using Dursban , Dimethoate, or Sumithion/Fenithrotrion primarily for pests and Kitazin 48 EC, Fernasan, or Orius for fungus. Seed treated with Thiram have increased resistance to fungus. All directions and precautions associated with chemical use should be followed carefully.
- Harvesting---Drain fields 10 days prior to harvesting (110-150 days after transplanting). Cut rice stems, bundle and transport to threshing facility with final drying to 12% moisture before threshing and storing.

Tomato/Tomate (Burundi)

Important considerations in selecting field sites

- Optimum temperatures for tomato production are between 20-27° C.
- Tomatoes **must be rotated** with other crops (e.g wheat, maize, or following rice) and **should not** be planted in a field previously planted to tomatoes, eggplants, potatoes, or peppers during the last 3 cropping seasons.
- Tomatoes require well-drained soils and are damaged by waterlogging. Preferred soil pH is between 6.0-7.0.

1. Seedling Production, Land Preparation and Fertilization

Seedling preparation— Mix 3-5 kg of compost into shaded raised seed bed. If fungal diseases are suspected, apply fungicides (e.g. Ridomil Gold, Captan) to the seed bed or treat seed with Thiram prior to planting in rows (500 g tomato seed/100 ares) and lightly covering. Irrigate the bed with fine spray immediately after sowing and during seedling growth. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Ten days prior to transplanting, expose the seedlings (~ 4 weeks old) to 6-9 hours of direct sunlight each day. Twelve hours prior to transplanting, thoroughly water the seedlings.

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.5, broadcast and incorporate 20 kg dolomitic lime/are to a 15 cm depth on Plot 2 immediately following land preparation and preferably 2 months prior to planting. Lime application should be sufficient for three subsequent seasons (2010 Season B, 2011 Seasons A and B). Raised beds (1.5 m between furrows) should be used for soils with poor drainage.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (0.4 kg/are or plot) and KCL (0.3 kg/are or plot) and ½ the dose of urea (0.6 kg/are or plot).

Side Dressing— The remaining ½ dose of urea (0.6 kg/are or plot) should be side-dressed at six weeks after transplanting. Fertilizer should be worked lightly into soil around each plant. Foliar

application of secondary nutrients (Ca and Mg) should be considered on soils with pH < 5.5 if lime wasn't incorporated into Plot 2 at least 2 month prior to planting. Foliar fertilization with micronutrients zinc (Zn), boron (B) and copper (Cu) solutions are reported to increase product quantity and quality but the economics of use remains questionable. .

1. Cultural Practices

- Plot size—10 m x 10 m (1 are) on raised beds
- Variety—Ana or Roma
- Seedling rate— 133-156 plants/are
- Planting density— For raised beds use 1.5 m (furrow to furrow) with a single row of tomatoes planted in middle of the bed with holes/plants spaced 50 cm apart. For soils not subject to water logging the spacing is 80 cm x 80 cm. Seedlings should be transplanted in the late afternoon in holes dug along in the row furrow. Cover the plant root with soil and water the base of plant.
- Mulch around each plant
- Stake and string the tomato plants to keep fruit off the ground.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is essential for controlling soil borne diseases and some pests associated with tomatoes. Certified seed and resistant seed (if available) can also help control diseases. Control pest and diseases on Plot 2 using Dursban or Rogor for insects and Dithane M 45 or Ridomal MZ 68 for powdery mildew, alternaria, and anthracnose. All directions and precautions associated with pesticides should be followed carefully. Liming will help prevent blossom end rot due to calcium (Ca) deficiency in tomatoes.
- Harvesting---Tomatoes grown for the fresh market require frequent picking and should be stored in the shade until sorted and graded. Marketable fruits should carefully packaged to prevent injury and reduce water loss. Mature-green tomatoes can be stored 7-10 days in cold storage (13-18° C and 85-90% relative humidity). Tomato varieties designed for processing (e.g. Roma) are left on the vine until 85% of the fruit is ripe. If picked for whole tomatoes pick while still firm.

Eggplant/Aubergine (Burundi)

Important considerations in selecting field sites

- Optimum daytime temperatures for eggplant production are between 25-35° C with night temperatures of 20-27° C. Eggplants are drought tolerate. Productivity is significantly reduced at altitudes > 800 m.

- Eggplant **must be rotated** with other crops (e.g wheat, maize, or following rice) and **should not** be planted in a field previously planted to tomatoes, eggplants, potatoes, or peppers during the last 3 cropping seasons.
- Eggplant requires well-drained sandy loam soils. Preferred soil pH is 6.0-7.0 with an optimum pH of 6.4.

1. Seedling Production, Land Preparation and Fertilization

Seedling preparation— Mix 3-5 kg of compost into the raised shaded seed bed. If fungal diseases are suspected, apply fungicides (e.g. Ridomil Gold, Captan) to the raised seed bed or treat seed with Thiram prior to planting. Seeds are planted in rows 10 cm apart (and spaced so to make transplant removal easy) and lightly covered. Irrigate the bed with fine spray immediately after sowing and during seedling growth. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Six to nine days prior to transplanting, expose seedlings to increasing direct sunlight and reduce watering slightly each day. Twelve hours prior to transplanting, thoroughly water the seedlings.

Land Preparation—Land (raised beds if poor drainage) should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.5, dolomitic lime (20 kg/are) should be added to Plot 2 via broadcasting and incorporation to a 15 cm depth immediately after land preparation and preferably 2 months prior to planting. Lime application should be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Seasons A and B). Raised beds (1.5 m between furrows) should be used for soils with poor drainage.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (.4 kg/are or plot) and KCL (0.3 kg/are or plot) and ½ the dose of urea (0.6 kg/are or plot).

Side Dressing— Six weeks after transplanting side-dress the eggplants with the remaining ½ dose of urea (0.6 kg/are or plot). Work fertilizer lightly into soil around each plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1 are)
- Variety—Tengura white
- Seedling rate— 260 plants/are
- Planting density—For raised beds use 1.5 m (row to row) with a single row of eggplants planted in middle of the bed with holes/plants spaced 50 cm apart. For soils not subject to water logging use a 80 cm x 80 cm spacing. Seedlings (with 3-4 true leaves) should be transplanted in the late afternoon in the row. The eggplant seedling should be plant to a depth where its first true leave is just above the soil surface. Water the base of each plant.
- Mulch around each plant

- Stake and string the eggplant if necessary to keep fruit off the ground.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases. Control insects and diseases on Plot 2 only using Dursban or Rogor for insects and Dithane M 45 or Ridomal MZ 68 for powdery mildew, alternaria, and anthracnose. All directions and precautions associated with pesticides should be followed carefully.
- Harvesting---Harvest begins 3-4 weeks after flowering. Harvest by hand leaving a short stem attached to the fruit. Eggplant should be firm and free of cuts or scars. Eggplant does not store well and should be marketed immediately. Fruits are generally sorted by size and color and should be packed carefully for transport. If cold storage exists, eggplant can be stored for 7-10 days at 7-10° C and 90-95% humidity. Do not store below 7° C.

Potato/Pomme de terre (Burundi)

Important considerations in selecting field sites

- Potatoes are primarily grown as a sole crop in cool climates where day time temperatures range between 20-25° C and night time temperatures are below 20° C. Cultivation is concentrated in altitudes between 1200-3000 m.
- Potatoes **must be rotated** with other crops (e.g wheat, maize, rice or legumes). Potatoes **should not** be planted in a field previously planted to potatoes, tomatoes, eggplants, or peppers during the last 3 cropping seasons. Potatoes following cabbage or mustard crops are less susceptible to bacterial wilt and nematodes.
- Potatoes require a well distributed rainfall of 500-750 mm and well-drained soils. Preferred soil pH ranges from 4.8-6.

1. Land Preparation and Application of Fertilizers

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, dolomitic lime (40 kg/are or 100 kg/plot) should be added to Plot 2 via. broadcasting and incorporation to a 15 cm depth immediately after land preparation and preferably 2 months prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (0.8 kg/are or 2 kg/plot) and KCl (0.6 kg/are or 1.5 kg/plot) and 1/3 dose of the urea (0.47 kg/are or 1.2 kg/plot). Level the soil before digging holes for the seed potatoes.

Side Dressing—The remaining urea (0.9 kg/are or 2.3 kg/plot) should be side dressed in two equal applications when the plants reach 15 cm and at flowering. Urea should be mixed lightly into the soil around each plant.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—Ndinamagara, Ingabire
- Seedling rate— 25 kg/are or 62.5kg/plot
- Planting density—80 cm x 50 cm
- Other cultural practices: control weeds on Plots 1 & 2 and earth up at 14 days after planting. Crop rotation is essential for controlling soil borne diseases and some pests on potatoes. Use of certified seed and resistant seed also helps control diseases. Control insects and diseases on Plot 2 only using Dursban, Rogor, or Fenithroton for pests or Ridomal MZ 68 or Dithane M 45 as fungicides. All directions and precautions associated with chemicals should be followed carefully.
- Harvesting---Potatoes are ready for harvest between 3-4 months after planting. The aboveground biomass (haulm) should be removed 10-14 days before lifting the potatoes. After harvesting the potatoes should be allowed to dry in heaps for 1-2 weeks in the field or preferably at 10-20° C (or in cold storage) under high humidity. All damaged tubers should be removed before the tubers are sent to market. On farm storage should be in a well-ventilated dark building.

Wheat (Burundi)

Important considerations in selecting field sites

- Wheat is best adapted to deep, well-drained soils of medium texture and medium-to-high fertility. Wheat tolerates poorly drained, heavy-textured soils better than other small grains, but may “drown out” in extremely wet areas. Wheat is more susceptible to diseases under high-humidity conditions.

1. Land Preparation and Application of Fertilizers

Land Preparation—prepare the land at least 4 months before the onset of rains. If the soil pH is < 5.5 lime (~ 75 kg/plot) should be broadcast and incorporated into the soil to a depth of 15 cm immediately following land preparation. This dosage should be sufficient for the next three cropping seasons (2010 Season B and 2011 Seasons A and B). Crop residues and composted manure (100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil at a 15 cm depth the entire dose of DAP (1.0 kg/are or 2.5 kg/plot).

Side Dressing—side dress urea at a rate of 1 kg/are or 2.5 kg/plot and mixed into the soil surface (to extent possible) 6 weeks after planting.

Foliar fertilization –spraying wheat with Bayfolan [11-8-5]) at 4 weeks and just prior to booting is reported to improve wheat quality.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— Mbayuwayo
- Spacing — 20 cm x 20 cm. Furrows/rows should be 20 cm apart with a 20 cm within row spacing between seeds.
- Planting— with the onset of rain, seed should be applied at a rate of 1.0 kg/are or 2.5 kg/plot. Seed should be planted to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases On Plot 2 only control insects by spraying with Cypermethrine 50 EC, Decis EC 2.5, or Dimethoate. For fungicide control use Orius or copper (Cu) based fungicides. Carefully follow all directions for chemicals use including latest time for application.
- Harvesting— Harvest wheat at approximately 13% moisture. Residues not used for fodder or fuel should be incorporated back into soil during next cropping season.

Green Peas/Petit pois (Burundi)

Important considerations in selecting field sites

- Peas prefer a cool moist climate but grow reasonably well between 10-30° C. The optimum temperature is 20° C. Crop must be grown at altitude >750 m.
- Peas should be rotated with cereals, potatoes or *Brassica* (e.g. cabbage).
- Peas require a minimum of 400-500mm well distributed rainfall during the three month growing cycle. Peas grow on a wide range of soils, but prefer a well-drained soil with high organic matter content. Optimum soil pH range is 6.0-7.7.

1. Land Preparation and Fertilization

Land Preparation—Land should be prepared (hoed) early and weeds removed to promote pest death (e.g. cutworms). For soils with pH<5.5, broadcast and incorporate 50 kg/are or 125 kg/plot of lime to a depth of 15 cm immediately after land preparation and preferably 2 months prior to planting. This lime application is sufficient for three subsequent cropping season (2010 Season B,

2011 Seasons A and B). Prior to planting and fertilization, incorporate crop residues and composted manure (100 kg/are or 250 kg/plot) into top 20 cm of soil.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (0.5 kg/are or plot), then level the soil for planting.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—MASHIGHSA
- Seedling rate—80-90 kg/ha (0.85 kg/are or 2.1 kg/plot)
- Planting density—40 cm x 20 cm. Inoculation of seeds with *Rhizobium* (40 kg of inoculum/2 kg seed) prior to planting is recommended to improve nitrogen (N) fixation. Seeds are sown directly into moist soil in rows (40 cm between rows) with 20 cm spacing between seed. Seed should be planted to a 2.5 cm depth in deep soils or a 4 cm depth in drier lighter soils.
- Other cultural practices: control weeds on Plots 1 & 2 and maintain moisture. If conditions become too dry, irrigation will be required to save the crop. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects and diseases on Plot 2 only using Cypermethrine 50 EC, Decis EC 2,5 or Rogor primarily for pest associated diseases. Ridomal MZ 68 can be used as a general fungicide. All directions and precautions associated with chemicals should be followed carefully. Additional actions to prevent disease include preparing field early to promote death of soil borne pests and removing crop residues immediately after harvesting.
- Harvesting---Harvest 8-12 weeks after planting. Pods should be well filled, but smooth and green. For the fresh market, harvested peas are sorted and packed but not washed. Discarded peas are excellent fodder.

Strawberries (Burundi)

Important considerations in selecting field sites

- Strawberries thrive best in temperate climates. Production in some countries (e.g. Kenya) is limited due to the scarcity and high cost of planting material. Only day-neutral varieties should be grown.
- Strawberry requires a well-drained medium loam soil, rich in organic matter. Optimum pH is 5.7-6.5.
- Strawberries should not be planted where potatoes, tomatoes, peppers, eggplants, strawberries or raspberries have grown within three years.

1. Seedling Production, Land Preparation and Fertilization

Seedling—Propagation is mainly by crown division because the continuous short day condition in the tropics does not favor strawberry runner production, the primary propagation material. While this increases the possibility of disease, producing plants from seed is difficult.

Land Preparation—Prepare land digging as deep as possible. Incorporate crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, dolomitic lime (25 kg/are) should be broadcast and incorporation to 15 cm depth immediately after land preparation and preferably 2 months prior to planting. This application should be sufficient for 3 additional cropping seasons (2010 Season B, 2011 Seasons A and B). Strawberries production is typically on raised beds.

Basal Fertilizer Application—Broadcast and incorporate into the soil at a depth of 15 cm the full dose of DAP (0.4 kg/are or plot), KCL (0.3 kg/are or plot) and ½ of the urea (0.35 kg/are or plot). Level the soil on the bed before planting.

Side-Dressing—Four - six weeks after transplanting, side dress the strawberry plants with the remaining ½ of urea (0.35 kg/are or plot). The fertilizer should be lightly mixed into the soil around the plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1 are)
- Variety— Sekoya
- Seedling rate— ~ 166-222 plants/are
- Planting density—1 m x 45-60 cm. For raised beds plant 1 row in the middle.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases. Crop should be inspected frequently for physical removal of insects. In the past methyl bromide was used to control pests, but its use is being phased out. If chemicals are required for controlling pest and disease on Plot 2, Rogor and Ridomil 480 EC can be used to control insect and fungal diseases. All directions and precautions associated with chemical treatments should be followed carefully.
- Harvesting---Harvest time will depend on the production system. In a matted row system, growers attempt to have 3-4 crops from a single planting, but the crop typically requires a year to produce. If the annual plasticulture system is used, a crop can be harvested at 6 months. Other advantages include less susceptible to disease and weed competition, but a significant disadvantage is cost. Strawberries are ready for harvest when the fruit turns red but is still firm. Strawberries must be harvested every 2-3 days and must be marketed quickly. Strawberries are

one of the leading crops for retaining chemical residues so they must be washed thoroughly before consumption.

Onions/Oignons (Burundi)

Important considerations in selecting field sites

- In the tropics only short day or day neutral onion varieties will form bulbs. Optimum temperatures for onion production range from 15-30° C.
- Onions **must be rotated** with other crops to prevent build-up of pests and disease including nematodes, *Sclerotium* and *Fusarium*. Onions **should not** be planted in a field previously planted to other *Allium* plants (e.g. garlic) or maize.
- Onions will produce on any fertile well-drained non-crusting soil. Optimum pH is between 6.0-6.8. Onions do not grow well on soils with pH<6.0.

1. Seedling Production, Land Preparation and Fertilization

Seedling preparation— Mix 3-5 kg of well-decomposed compost into the shaded raised seed bed (1 m wide). Seeds (rate of 20-30 g/are) are planted in rows 15 cm apart (and spaced so to make transplant removal easy) and lightly covered with soil and mulch. Irrigate the bed with fine spray immediately after sowing and during seedling growth. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Six to nine days prior to transplanting, increase seedlings exposure to direct sunlight and reduce watering slightly each day. Twelve hours prior to transplanting, thoroughly water the seedlings. Seedlings require 6-8 weeks growth before transplanting. Prune roots when transplanting.

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (250 kg/are) prior to fertilization and planting. For plots with soil pH < 6.0, dolomitic lime (20-30 kg/are) should be added to Plot 2 via. broadcasting and incorporation to a 15 cm depth as soon as land preparation is complete—preferably 2 months prior to planting. This lime application will be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Seasons A and B). Raised beds of 0.9-1.0 m width are common with 2-6 rows of onions planted on the bed. Raised beds are required for soils with poor drainage.

Basal Fertilizer Application— Before planting, broadcast and mix into the soil at a 15 cm depth the entire dose of DAP (0.4 kg/are or plot), and KCl (0.3 kg/are or plot) and ½ of urea (0.6 kg/are or plot).

Side-Dressing—Four weeks after transplanting, side dress the onions with the remaining ½ of urea (0.6 kg/are or plot). The fertilizer should be lightly mixed into the soil around the plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1 are)
- Variety— Red Creole, Red Tropicana F1 Hybrid
- Seedling rate— ~ 1500 plants/are
- Planting density—30 cm x 15 cm. For raised beds of 0.9-1 m width plant 3 rows on each bed with 30 cm between rows and 15 cm between plants.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects and diseases on Plot 2 only using Cypermethrine 50 EC, and Decis EC 2.5, for insects. Dithane M 45 can be used as a fungicide, but should not be sprayed on exposed bulbs. All directions and precautions associated with chemical treatments should be followed carefully.
- Harvesting---Harvest begins 90-150 days after planting. Onions are ready for harvest when leaves collapse. After removing the bulbs by hand, they should be windrowed and allowed to dry. The leaves are removed and the bulbs are bagged or packed in crates. Freshly harvested onions are dormant and will not sprout for some time if put in cold storage.

Passion Fruit (Burundi)

Important considerations in selecting field sites

- The purple/gray passion fruit performs best in cooler environments at higher altitudes (1200-1800 m) and temperatures (18-25° C), whereas the yellow passion fruit prefers the tropical lowlands (0-800 m and 25-30° C). Vines prefer sheltered locations without extreme temperatures.
- Soils of medium texture with good drainage, rich organic matter and aeration required. Passion fruit is a deep rooting plant, hardpan must be removed. Optimum pH is 5.5-6.0.
- Passion fruit can be intercropped with beans and cabbages. Do not intercrop with cereals, cowpea or creepers (e.g. sweet potato).

2. Seedling Production, Land Preparation and Fertilization

Seedling production—For nursery production, rub seed clean of pulp and dry in shade. Sow seed (1.5-2.5 cm deep) in a shaded seed bed in rows with 10 cm spacing. After seed germinate (2-4 weeks) allow seedling to reach a30 cm length with 3-4 nodes prior to transplanting to the field. Select only quality cuttings.

Land Preparation—Prepare land digging as deep as possible. Incorporate crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0,

dolomitic lime (30 kg/are) should be broadcast and incorporation to 15 cm depth immediately after land preparation and preferably 2 months prior to planting. This application should be sufficient for 3 additional cropping seasons (2010 Season B, 2011 Seasons A and B).

Basal Fertilizer Application—Broadcast and incorporate into the soil at a depth of 15 cm the full dose of DAP (0.4 kg/are or plot), KCL (0.3 kg/are or plot) and urea (0.7 kg/are or plot). Level the soil before digging holes (45 cm x 45 cm x 45 cm) every 3m within the row for the seedlings. At the start of the rainy season, seedlings should be place in the hole, watered and covered with soil.

Additional Fertilization--For years 2 and 3 mix 0.68 kg of NPK (17-17-17) into soil around each plant.

3. Cultural Practices

- Plot size—10 m x 10 m (1.0 are)
- Variety—Passiflora edulis (purple/grey)
- Seedling/Cutting rate—16 seedlings/are
- Planting density—1.8-2 m x 3 m. Rows should be approximately 2 meters apart with 3 meters between seedlings/cuttings within rows.
- Other cultural practices: control weeds on Plots 1 & 2. Passion fruit vines require strong trellis support. A single wire trellis of 14 gauge galvanized wire stretched along the top of post (15 cm in diameter x 3 m length and placed at a depth of 0.6 m) placed every 8 meters works well in the field. This model should be adopted for plots 1 and 2 and should be erected when the field is planted. The main shoot and one vigorous lateral should be tied to the wire with string. As vines reach the wire they should be trained in the opposite direction. Maintenance pruning is required to remove all laterals below the wire, damaged branches or branches with no fruits. Laterals along wire are allowed to hang down. Tendrils should be removed to increase aeration and promote light interception. Crop rotation is the best method for controlling soil borne diseases and some pests. Cuttings/seedlings generated from quality stock help control diseases. Protect vines against birds and rats. Control insects and diseases on Plot 2 only using Rogor. Rotate land to another crop after productive cycle ends (3-4 years) to prevent buildup of soil borne diseases (e.g. nematodes). Purple/grey passion fruit is more susceptible to nematodes than yellow. All directions and precautions associated with chemicals should be followed carefully.
- Harvesting---Harvest at approximately 8 months after transplanting. Passion fruit for the fresh market should be picked at full color development. For processing, the fruit should be picked at near maturity (shriveled and unattractive). Ripe fruit will store (cold storage) for a limited time.

Beans/ Haricot (Burundi)

Important considerations in selecting field sites

- Optimum temperature for production is 20-25° C between altitudes of 1000-2100 m. Well distributed rainfall between 900-1200 mm is sufficient, but beans growing during the dry season will require up to 50 mm of water per week via. irrigation.
- Well drained, silty loam to heavy clay soils high in organic matter are preferred. Optimum pH level is 5.5-6.5.
- Green beans for the market can be planted at 2-3 week intervals starting in mid-August until the end of February.

1. Land Preparation and Fertilization

Land preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are or 250 kg/plot) prior to fertilization and planting. For plots with soil pH < 5.0, dolomitic lime (20 kg/are or 50 kg/plot) should be broadcast and incorporated to a depth of 15 cm after initial land preparation. This application should be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Season A, and 2011 Season B).

Basal Fertilizer Application—Broadcast and incorporate into the soil to a depth of 15 cm the full dose of DAP (0.5 kg/are or 1.25 kg/plot) then level the soil.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—AND 10; G13607
- Seeding rate—60 kg/ha (.6 kg/are) for climbing beans and up to 120 kg/ha (1.2 kg/are) for bush (dwarf) beans
- Planting density—For bush beans use 40 cm x 20 cm for single rows with 40 cm width between rows and 20 cm between seed within row. For climbing beans 4-6 beans are sown together in hills (spaced 1 m apart) or beans are sown in rows 90-120 cm apart within row spacings of 15-30 cm. Beans should be sown at a depth of 3-6 cm.
- Other cultural practices: For a pure stand of beans (sole crop) it is preferable to construct slightly raised beds 1 m in width. Beans can be intercropped with maize, sorghum, potatoes, etc. Control weeds on Plots 1 & 2. Climbing cultivars require stakes or trellis up to 2.5 m in height for support. Avoid planting beans near other leguminous crops (e.g. soybean) that may be a source of bean flies. Control weeds on plots 1 and 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds helps control diseases. Control insects and diseases on Plot 2 only using Rogor, Cypermethrine 50 EC or Decis EC 2,5. Rotate with other crops to prevent buildup of soil borne diseases (e.g. bean rust, powdery mildew, anthracnose and fusarium root rot) and to take advantage of nitrogen (N) fixed by bean crop.

- Harvesting---Harvest begins at 7-8 weeks after sowing for early cultivars. Beans should be picked every 2-3 days. Climbing beans produce larger yields. Saved beans should be shelled, dried and stored in an air tight container. Addition of ash/chili mixture to stored beans can help prevent weevils.

Legume Forage (Burundi)

Important considerations in selecting field sites

- Common species used in East Africa for fodder is *Calliandra calothyrsus*. Thrives in temperatures between 18-28°C and tolerates rainfall between 700-3,000 mm. Semi-drought tolerant, but does not tolerate water logging nor shade. Grows best at altitudes < 2000 m.
- *C. calothyrsus* grows well on a wide range of soils ranging from deep volcanic loams to acidic sandy clays. Well adapted to acid infertile soils, and responds to fertilization.
- Multipurpose tree (e.g firewood) and highly productive in humid and highland tropics. Recommended for cut and carry feeding not for direct feeding by ruminants.

1. Seedling Production, Land Preparation and Application of Fertilizers

Nursery Seedlings—Nursery seedlings of height 20-50 cm are preferred. Seedlings can be produced from seed (18,000-20,000 seed/kg). Seed must be soaked in cold water for 48 hours before planting at a depth of 1-3 cm. Germination should occur in 4-10 days. Seedling will be ready for field planting in 6-12 weeks when 20-50 cm tall.

Land preparation—incorporate crop residues (cereal straw or leguminous leafage) to the plot after land preparation.

Basal Fertilizer Application—Broadcast and incorporate to a depth of 15 cm the full dose of DAP (1.25 kg/plot). Level the soil and dig holes for the *Calliandra* seedlings.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 ares)
- Variety—*Calliandra calothyrsus* (Embu landrace-Kenya)
- Seedlings— 100 per are
- Spacing—for fodder banks 1m x 1m grid or in hedgerows 2 m x 50 cm
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases. Significant pest and diseases including heavy infestation of scale insects are starting to appear on *Calliandra*, particularly in Uganda. Rogor applied as spray at first sign of infestation is recommended. Do not remove any forage for livestock feeding for at least 7 days after spraying. All directions for chemical treatments should be followed carefully.

- Harvesting---First cut should be 8-12 months after sowing. For maximum leaf production cut to a height of 0.5-1.0 m every 2-3 months. Produces 3-14 t/ha/yr.

Grass Forage (Burundi)

Important considerations in selecting field sites

- *Tripsacum andersonii* commonly referred to as *Tripsacum laxum* is widely distributed in the tropics. Prefers temperatures between 18-30°C, requires reliable rain for maximum growth, tolerant of water logging and drought.
- *Tripsacum andersonii/Tripsacum laxum* grows well on soils ranging from deep volcanic loams to acid sulphate soils, prefers well drained fertile soil. Heavy fertilization required for optimum growth. Can be intercropped with fodder legumes such as *Calliandra calothyrsus*. Tolerates 50% shade. Used as a break to control bacterial wilt for potatoes in Burundi.
- Highly productive in humid tropical lowlands but provides moderate growth to altitudes of 1800 m. Will not grow in wet peat lands found in high altitudes of Burundi. Recommended for cut and carry feeding not for direct feeding by ruminants.

1. Land Preparation and Application of Fertilizers

Land preparation—incorporate crop residues (cereal straw or leguminous leafage) to the plot after initial land preparation.

Basal Fertilizer Application— Broadcast and mix into the soil to a depth of 15 cm the full dose of urea(0.4 kg/are or 1 kg/plot), DAP (0.4 kg/are or 1 kg/plot) and KCl (0.3 kg/are or 0.75 kg/plot), then level the soil for planting.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 ares)
- Variety— *Tripsacum andersonii/Tripsacum laxum*
- Cuttings/Seedlings— 200 stem cuttings per are. Stem cuttings should have 3 nodes, rooted culms or rhizomes.
- Spacing—0.5 m x 1m. Stem cutting should be planted within two days to a depth of 5 cm on moist soil, or 10 cm on drier soils. Transplanting should be done late in afternoon. Plants should be irrigated immediately following planting.
- Other cultural practices: control weeds on Plots 1 & 2 to the extent possible. Manage land for quality livestock cuttings. Unmanaged stands can become invasive and create control issues due to high labor required to dig out rhizomes.

- Harvesting---First cut at 4-6 months after planting. Cut at 30 day intervals during the wet season and 45 day intervals during dry season. For maximum leaf production cut to a height of 0.5-1.0 m every 2-3 months. Produces 18-22 t/ha/yr.

Patchouli (Burundi)

Important considerations in selecting field sites

- Patchouli prefers a warm humid climate with optimum temperatures between 24-28° C and an annual rainfall between 1500-3000 mm.
- Patchouli requires deep, well-drained, loamy fertile soils, rich in organic matter. Slightly acidic soils (pH 5.2-6.0) are much preferred. Heavy clay and sandy soils should be avoided as well as nematode infested area.
- Patchouli is a perennial crop but yield declines after about 3-4 cuttings. The first 3-4 cuttings produce higher quality leaf material.

1. Land Preparation and Application of Fertilizers

Land preparation—incorporate crop residues (cereal straw or leguminous leafage) and 250 kg of organic matter to the plot after land preparation.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (0.4 kg/are or 1.0 kg/plot) and KCl (0.3 kg/are or 0.75 kg/plot). Minjingu phosphate rock (PR) could be substituted for DAP if available. Level the soil, dig holes for patchouli cuttings, adding water to the holes prior to planting the cuttings in late afternoon. Tips should be removed at planting or 20-30 days after planting to encourage early branching. Mulch around the base of plant at 45-60 days.

Top Dressing—Urea (1.2 kg/are or 3 kg/plot) should be applied top dressed in 4 equal split applications at 45, 90-100, 135-145 and 170-180 days after transplanting.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 ares) raised beds preferred
- Variety—Jahore and Singapore ? (variety not confirmed)
- Cuttings— 290 per are
- Spacing—60 cm x 60 cm
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds helps to control diseases. Control insects and diseases on Plot 2 only. Leaf and stem gall are treated by spraying with Bavistan (0.25-30%) for 2-3 times at 7-10 day intervals after

removing affected branches. Myriad bug are controlled by spraying Dime 30 EC (Rogor, Tara 909) and mites are controlled by 1-2 spraying with Kelthane or Ethion. Furdan granules at 2.5 g/plant can help to control nematodes. Marigolds planted in the fields will also help control nematodes. Nematode infested areas should be avoided.

- Harvesting---A partial harvest occurs at 60-65 days. At 90-100 days, the first regular harvest of selected matured branches (70-90 days old) takes place. Harvest requires cutting the plant back to 3-4 nodes from the base to promote re-growth. Harvest during cooler hours (early morning or late afternoon). Herbs should be spread out on mats or tarpaulins for drying (under shade for 7-10 days) and should be turned once a day. Dried leaves should be packed tightly in bags and stored for at least 3 months. Storage bags should be hung so not to touch the ground.

Cassava (Burundi)

Important considerations in selecting field sites

- Optimum temperature for production is 20-30° C. Cassava is grown to an altitude of 1500 m with an optimal rainfall 1000-1500 mm. Once established, cassava is resistant to severe drought.
- Well drained sandy loam soil is preferred, but cassava can produce reasonable yields on infertile and eroded soils. Optimum pH level is 5.5-6.5, but some cultivars can tolerate a pH as low as 4.6 or as high as 8.0. Very fertile soils promote excessive foliage and reduce root yield.
- Bitter cassava varieties must be properly processed to reduce toxic levels of cyanogenic glucoside content (HCN). Sweet varieties can be eaten raw and fresh due to low levels of HCN.

1. Cuttings Selection, Land Preparation and Fertilization

Cuttings-- From healthy plants 8-14 months old, select cuttings 20-30 cm long and 20-25 mm in diameter with 5-8 nodes. Slight pest infection of cuttings can be treated by immersing cutting in heated water (50:50 hot:cold) for 5-10 minutes just before planting. Cuttings must be planted within 2 days of selection.

Land Preparation—Soil should be worked with hoe to a depth of 10-15 cm with incorporation of crop residues prior to fertilization and planting. If water-logging or erosion is a problem mound or ridge the soil (1m x 1m) meter for planting the cuttings. This practice makes harvesting easier. If land is flat and there is no danger of water logging, cuttings can be planted on level ground.

Fertilizer Application—One month after planting cuttings side-dress full dose of DAP (0.8 kg/are or 4 kg/plot) and KCl (0.6 kg/are or 3.0 kg/plot) around the plants mixing into the soil as much as possible. Urea (0.4 kg/are or 2 kg/plot) is side-dressed 3 months after planting and mixed into the soil around each plant.

2. Cultural Practices

- Plot size—25 m x 20 m (5.0 are)

- Variety—ABEY-IFE; MM967204
- Seeding rate—100 cuttings/are
- Planting density—1 m x 1 m for sole crop. For dry soils plant cuttings at an angle and cover the larger part with soil. For sandy soils use vertical planting to encourage deeper root growth. Horizontal planting should be avoided because it produces a number of thin stems susceptible to lodging.
- Other cultural practices: Cassava can be intercropped with cowpea or groundnut or in tree crops such as *Leucaena*, *Canavalia* or *Crotalaria*. Control weeds on Plots 1 & 2. To control insects and disease, select only healthy cuttings from disease resistant varieties and plant early in the rainy season. Rotate with other crops to prevent buildup of soil borne diseases.
- Harvesting---Harvest at 9-12 months. Fresh harvested cassava does not store well and therefore must be processed (e.g. peeled, chopped and dried). It can be stored for a significant time as chips or ground flour under dry conditions.

RWANDA

1. Project: CATALIST
2. Objective: Promote market oriented production in the focus regions of Rwanda based on a comparison of farmers' practice to CATALIST best bet technologies and recommendations. These technologies and recommendations are expected to result in maximum economic yields for the producer.
3. Crop-Location

Ananas (pineapples)	-Bugesera
Blé (wheat)	-Gicumbi
	-Musanze Burera
Petit pois (green peas)	-Gicumbi
	-Rulindo
Mais (maize)	-Nyabihu
	-Huye
	-Nyamagabe
	-Kamonyi
	-Muhanga-Ruhango
	-Muhanga
Maracuja (Passion fruit)	-Muhanga
	-Rulindo
Soya (soybean)	-Muhanga
	-Gisagara
	-Cyeza-Muhanga
	-Kamonyi
	-Ruhango
Pomme de terre (potatoes)	-Nyabihu
Manioc (cassava)	-Kamonyi
Riz (rice)-irrigated	-Muhanga-Ruhango
Tomate (tomato)	-Ngoma
Legumes (vegetables)	-Kamonyi

4. Design: The demonstration trial for each group of farmers/producers will consist of two plots (treatments) for comparison. Plot 1 will be the farmer's normal practice and will vary by farmer. For example, if the farmer normally uses composted manure and saved seed then this plot will be planted using only composted manure and saved seed. If the farmer typically uses some fertilizer (e.g. potato farmers) in addition to composted manure, then the plot will include fertilizer. Plot 2 will be planted based on CATALIST recommendations for each crop including inputs ((fertilizers, improved seed, integrated soil fertility management [ISFM] strategies (crop residues, composted manures, and possibly lime depending on soil pH and crop requirements)) at recommended application

rates. Plot 2 should always include incorporation/recirculation of any cereal straw or leguminous leafage not used for animal feed. Plot 2 will also be managed carefully to prevent pest and disease and may require the use of pesticides. Other maintenance activities such as weed control and irrigation for paddy rice should be done in both plots. Plots 1 and 2 should be located side by side (on sloping ground the 2 plots will be arranged on the same contour perpendicular to direction of the slope) with a sufficient grass strip/distance between the plots to reduce pesticide drift or nutrient runoff. For the irrigated rice plots, bunds will have to be of sufficient height and strength to prevent the exchange of floodwater between the two plots for the entire season.

Below in Table 1 is the application rate for fertilizers and other inputs (composted manure and lime) specific to the plot size (1, 2.5 or 5 [manioc only] ares) required for Plot 2 for each crop. All DAP and NPK (17-17-17) will be basally applied while urea will be top-dressed in two (2) split applications depending on the growth stage, growth and weather conditions. Table 2 contains information on plant spacing, number of demonstrations, total area and quantity of seed required for the crop commodity value chains. Table 3 contains information on the varieties proposed for use in the demonstration trials for plot 2 that will be available for 2010 Season A. For future demonstration trials, CATALIST will work to identify new varieties (not currently available in the region, but commercially available) that produce better quality crops, higher resistance to disease and insects, and/or shorter duration growing cycles.

Table 1. CATALIST Recommendations for Fertilizer and ISFM Inputs for Plot 2-Rwanda.

Crop/Culture	Plot Size/ Superficie de la parcelle élémentaire (en ares)	Fertilizer Application ^a Rate Dose d'engrais (kg/ha)			Fertilizer Rate per plot/Quantité pour la parcelle avec engrais (en kg)			ISFM ^d Inputs/Autres intrants pour les deux parcelles
		Urée	DAP	NPK	Urée	DAP	NPK	
Pineapples/Ananas	2.5	150	0	200	3.75	0	5	Composted manure
Wheat/Blé	2.5	100	100	0	2.5	2.5	0	Composted manure
Green peas/Petit pois	2.5	0	50	0	0	1.25	0	Composted manure and 50 kg of lime pH <5.5
Maize/Mais	2.5	100	100	0	2.5	2.5	0	Composted manure and 50 kg of lime pH <5.5
Passion Fruit/Maracuja	1	50	0	100	0.5	0	1	Composted manure and 20 kg of lime pH<5.0
Soybean/Soja	2.5	0	50 ^b	0	0	1.25	0	Composted manure and 50 kg of lime if pH<5.5*
Potato/Pomme de terre	2.5	100	0	200	2.5	0	5	Composted manureand 100 kg of lime pH<5.0
Cassava/Manioc	5	0	0	200	0	0	10	-----
Rice/Riz (irrigated)	2.5	150	100	0	3.75	2.5	0	-----
Tomato/Tomate ^b	1	100	0	100	1	0	1	Composted manure
Green beans/Haricot	2.5	0	50 ^c	0	0	1.25	0	Composted manureand 50 kg of lime pH <5.0
Vegetable/Légumes (green peppers, eggplant)	1	100	0	100	1	0	1	Composted manure

^a NPK (17-17-17) and DAP to be basally applied. Urea to be split applied in two top dressings if conditions related to growth stage, growth, and weather conditions are favorable.

^b Possibility of secondary or micronutrient deficiencies exist with tomato. Additional fertilizer sources have been identified for importation.

^c Higher P rate will be required for volcanic soils (80 kg/ha) . TSP fertilizer (if available) maybe preferable to DAP for green beans if cost effective (TSP cost= or <DAP).

^d Available crop residues (cereal straw or leguminous leafage) should always be incorporated into field when not used for fodder. In addition composted manure is recommended for most crops. Lime is recommended for acidic soils once the pH drops to a level that would inhibit crops' response to fertilizers.

5. Monitoring and Evaluation: In order to properly maintain the demonstrations and to promote facilitators' oversight a timeframe for implementation of activities associated with establishment and maintenance of the demonstration plot will be required. In addition, there will be common measurements and activities required for each plot in each demonstration including:

- a. Planting date (should be the same for Plots 1&2)
- b. Germination date

- c. Plant survival rate
- d. Maintenance (e.g. weeding, irrigation) dates
- e. Pesticide treatment (dates) for insects (Plot 2 only) as needed. Plots should be checked at least twice weekly for insects and disease
- f. A brief report on field days for neighboring farmers including information on number of participants, farmers reactions and observations
- g. Yield sampling

6. Cultivation details by crop for **PLOT 2** can be found in Annex 1. Plot 1 of the demonstration will be the farmer's practice

Table 2. Planting density and quantities of seeds required in Rwanda

Crops	Planting density	Number of demonstrations	Total area Plots 1&2 (en ares)	Quantity of seeds
Pineapple/Ananas	60 cm x 60 cm Or 60 cm x 30 cm?	2	10	500-550 suckers
Wheat/Blé	20 cm x 20 cm 120-150 kg/ha	23	115	138-150 kg
Green Peas/Petit pois	40 cm x 20 cm	5	25	21 kg
Maize/Mais	70 cm x 30 cm 25 kg/ha	61	305	75 kg
Passion Fruit/Maracuja	2 m x 3 m ^a	3	6	96 cuttings
Soybean/Soja	40 cm x 10 cm 70-100 kg/ha	45	220	187 kg
Potato/Pomme de terre	75 cm x 30 cm	8	40	1000 kg
Cassava/Manioc	1 m x 1m	9	90	9000 cuttings
Rice/Riz	20 cm x 20 cm	7	35	14 kg
Tomato/Tomatoes ^b	80 cm x 80 cm	8	16	0.08 kg ^b
Vegetables/Legumes				
Green Beans	40 cm x 20 cm	4	8	8 kg
Sweet Pepper ^b	100 cm x 50 cm	4	8	0.10 kg ^b
Eggplant ^b	50 cm x 75 cm	4	8	0.12 kg ^b

^a Spacing needs to be verified against number of cuttings

^b Seeds –preferable to used seedlings if available.

Table 3. Proposed Sites, Varieties, Altitude, and Rainfall for Value Chains-Rwanda

Crops	Sites	Variety	Altitude (m)	Rainfall (mm)
Pineapple/Ananas	Bugesera	Cayenne lisse var Baron de Rothschild	850-1300	700-850
Wheat/Blé	Gicumbi	Musama, 161, KS Mwamba	>2000	1200
	Musanze-Burera	Bisagi, KS Mwamba	>1900	1500-1600
Green Peas/Petit pois	Gicumbi	Kyondo, Nyiragashaza	>2000	1200
	Rulindo	Kyondo, Nyagashaza	1600-1800	1100-1300
Maize/Mais	Nyabihu (high altitude)	Hybrid 628 (150-190 days to maturity)	>2000	1400-1500
	Huye (low altitude)	Zim 607	1200-1500	1000
	Nyamagabe	Hybrid 628 ^a	>2000	1400-1500
	Kamonyi (low altitude)	Zm 607	1200-1500	1000
	Muhanga&Ruhango (mid altitude)	Zm 607	1600-1800	1100-1300
Passion Fruit/Maracuja	Muhanga	Passiflora edulis (purple/grey)	1600-1800	1100-1300
	Rulindo	See above	1600-1800	1100-1300
Soybean/Soja	Muhanga	Peka 6	1600-1800	1100-1300
	Gisagara	Peka 6	1200-1500	1000
	Cyeza-Muhanga	Peka 6	1600-1800	1100-1300
	Kamonyi	Peka 6	1200-1500	1000
	Ruhango	Peka 6	1600-1800	
Potato/Pomme de terre	Nyabihu	Mabondo, Ou Gikungu	>1900	1500-1650
Cassava/Manioc	Kamonyi	192/0057 (Cyizere)	1200-1500	1000
Rice/Riz	Muhanga-Ruhango	WAT	1600-1800	1100-1300
Tomato/Tomate	Ngoma	ROMA, ANA	1300-1500	950-1050
Vegetables/Legumes	Kamonyi		1200-1500	1000
Green Beans	“	Saxa	“	“
Sweet Peppers	“	California Wonder	“	“
Eggplants	“	Tengeru White	“	“

^a Hybrid 628 requires 150 days to mature. No hybrid variety is currently available for high altitudes with a shorter growing season. CATALIST should continue to interact with CIMMYT, CIAT and the national research centers to determine if more suitable maize, wheat, and bean varieties are available. There is some disagreement between the PST and MDT on planting maize in Season A followed by wheat in Season B, particularly considering the desire to build wheat value chain in this area. Farmers indicated Season A is more favorable to maize production.

ANNEX 1

Pineapple/Ananas (Rwanda)

Important considerations in selecting field sites

- A warm humid climate free from extreme temperatures (25° C) and a rainfall of 1100 mm provide optimum conditions for production.
- A well-drained soil with high organic matter content, a fine tilth for effective rooting (filter presscake from sugar mills is an excellent source of organic matter) and a soil pH ranging from 4.5 to 6.5 is required.
- Pineapple flavor is affected by altitude. Production at altitudes <1350 m produces the sweet flavor preferred by the fresh market, 1350-1750 m produces the best quality fruit for processing and >1750 m produces poorer quality and more acidic fruit.

1. Land Preparation and Fertilization

Land Preparation—the land should be well prepared in the dry season with digging as deep as possible. The soil should be worked several times to produce a fine tilth. Crop residues, additional organic matter and composted manure (50-100 kg/are) should be worked into the soil prior to planting. The soil bed should be ridged to promote drainage and aeration and can be treated with fungicides and insecticides if needed. Nematode infested areas should be avoided. Lime the soil if the pH <4.5 with 20 kg/are to a depth of 15 cm. Each lime application should be sufficient for three subsequent crops (2010 Season B and 2011 Seasons A and B).

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose of NPK (17-17-17) (2 kg/are or 5 kg/plot).

Side Dressing—Urea (1.5 kg/are or 3.75 kg/plot) should be applied in three 3equal side dressings 1.25kg/plot around each plant at 4, 8 and 12 months.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 ares) raised or ridged beds preferred
- Variety—Cayena lisa (*var. Baron de Rothschild*)
- Spacing — Pineapple suckers should be spaced in double rows 60 cm apart on each side of the ridge with 60 cm spacing between the suckers within the row. Distance from ridge center to ridge center should be 1.5 m.
- Planting—Suckers should be planted at a depth of 9-10 cm and mulched with bagasse
- Flowering at 6 months can be induced with smoke or spraying with synthetic products (e.g. Ethrel at 1.5 ml/l of water and each plant receiving 30 ml; other products include ANA, BNA or BOH) in the late afternoon when the temperature is below 25⁰ C.

- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation (e.g. beans, rice, vegetables) is the best method for controlling soil borne diseases and some pests. Dipping suckers in approved chemicals prior to planting is common. Control insects and diseases on Plot 2 only using Ridomil MZ 72 as a fungicide and either Diazinon or Basudin as an insecticide. All chemicals should be used carefully and only at recommended dosages.
- Harvesting—Ethephon (30 ml/20 liters water) can be used to induce ripening one week prior to harvest. Fruits should be transported with crowns downward for cushioning.

Wheat/Blé (Rwanda)

Important considerations in selecting field sites

- Wheat is best adapted to deep, well-drained soils of medium texture and medium-to-high fertility. Wheat tolerates poorly drained, heavy-textured soils better than Other small grains, but may “drown out” in extremely wet areas. Wheat is more susceptible to diseases under high-humidity conditions.

1. Land Preparation and Application of Fertilizers

Land Preparation—prepare the land at least 4 months before the onset of rains. If the soil pH is < 5.5 lime (75 kg/plot) should be broadcast and incorporated into the soil to a depth of 15 cm immediately following land preparation. This dosage should be sufficient for the next three cropping seasons (2010 Season B and 2011 Seasons A and B). Crop residues and composted manure (100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil to a 15 cm depth the entire dose of DAP at a rate of 2.0 kg/are or 5.0 kg/plot.

Side Dressing—side dress urea at a rate of 1 kg/are or 2.5 kg/plot and mixed into the soil surface 6 weeks after planting .

Foliar Fertilization—Application of Bayfolan (11-8-5) at 4 weeks and just prior to booting may improve wheat quality.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— K S Mwamba
- Spacing — 20 cm x 20 cm. Furrows/rows should be 20 cm apart with a 20 cm spacing between seeds
- Planting— with the onset of rain seed should be applied at a rate of 1.0-1.5 kg/are or 2.5-3.75 kg/plot. Seed should be planted to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also

helps to control diseases On Plot 2 only control insects by spraying with Cypermethrine 50 EC, Decis EC 2.5, or Dimethoate. For fungicide control use Orius or copper (Cu) based fungicides. Follow carefully application directions for chemicals. Proper crop rotation will prevent a number of diseases.

- Harvesting— Harvest at approximately 13% moisture. Residues not used for fodder or fuel should be incorporated back into soil during the next cropping season.

Green Peas/Petit pois (Rwanda)

Important considerations in selecting field sites

- Peas prefer a cool moist climates but grow reasonably well between 10-30° C. The optimum temperature is 20° C. Crop must be grown at altitude >750 m.
- Peas should be rotated with cereals, potatoes or *Brassica* (e.g. cabbage, broccoli).
- Peas require a minimum of 400-500mm well distributed rainfall during the three month growing cycle. Peas grow on a wide range of soils, but prefer a well-drained soil with high organic matter content. Optimum soil pH is between 6.0-7.7. If the soil pH is less than 5.5, dolomitic lime should be applied. Lime application should be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Season A, 2011 Season B).

1. Land Preparation and Application of Fertilizers

Land Preparation—Land should be prepared/hoed early and weeds removed to promote pest death (e.g. cutworms). For soils with pH<5.5, lime (50 kg/are or 125 kg/plot) should be added to Plot 2 via broadcasting and incorporation to 15 cm depth after initial land preparation and preferably 2 months prior to planting. Prior to planting and fertilization, incorporate crop residues and composted manure (100 kg/are or 250 kg/plot) into top 20 cm of soil.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (0.5 kg/are or 1.25 kg/plot), then level the soil.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—Kyondo, Nyiragashaza, Nyagashaza
- Seedling rate—80-90 kg/ha (0.85 kg/are or 2.1 kg/plot)
- Planting density—40 cm x 20 cm. Inoculation of seeds with *Rhizobium* (40 kg of inoculum/2 kg seed) prior to planting is recommended to improve nitrogen (N) fixation. Seeds are sown directly into moist soil in rows (40 cm between rows) with 20 cm spacing between seed. Seed planted at 2.5 cm depth in deep soils or at a 4 cm depth in drier lighter soils.
- Other cultural practices: control weeds on Plots 1 & 2 and maintain moisture. If conditions become too dry, irrigation will be required to save the crop. Crop rotation is the best method

for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases. Control insects and diseases on Plot 2 only using Cypermethrine 50 EC, Decis EC 2,5 or Rogor primarily for pest associated diseases. Ridomal MZ 68 can be used as a general fungicide. All directions and precautions associated with chemicals should be followed carefully. Additional disease preventing measures include hoeing field well ahead of the crop planting to promote death of soil borne pests and removing crop residues for composting immediately after harvesting.

- Harvesting--- Harvest 8-12 weeks after planting. Pods should be well filled, but still smooth and green. For the fresh market, harvested peas are sorted and packed but not washed. Discarded peas are excellent fodder.

Maize/Mais (Rwanda)

Important considerations in selecting field sites

- Optimum temperatures range from 20-30° C and rainfall of 600-900 mm. Maize grows at altitudes > 2100 m but growth maturity days increase considerably above 1500 m.
- Soils for maize production should be well drained, well aerated and moderately deep with adequate organic matter and a pH of 5-8. Optimum pH is 5.0-5.7.
- Maize should be grown in rotation (e.g. wheat, potatoes, soybeans) or intercropped (e.g. beans, cassava) with other crops to prevent buildup of soil borne pests and diseases.

1. Land Preparation and Application of Fertilizers

Land Preparation—prepare the land one month before planting. If the soil pH is < 5.0, lime (20 kg/are) should be incorporated into the soil immediately following land preparation. This application will be sufficient for three subsequent cropping seasons (2010 Season, 2011 Seasons A and B). Crop residues and composted manure (50-100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Broadcast and incorporate into the soil to a depth of 15 cm the entire dose of DAP (1 kg/are or 2.5 kg/plot). Level the soil for planting.

Side Dressing—Urea (1.0 kg/are or 2.5 kg/plot) should be applied in two equal side dressing (0.5 kg/are or 1.25 kg/plot) when the crop is knee high and at silking.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— H 628 (high altitudes Nyabihu and Nyamagabe) and Zim 607 (low and mid altitudes Huye, Kamonyi, Muhanga)
- Spacing — 70 cm x 30 cm. Furrows/rows should be 70 cm apart within row spacing of 30 cm between seeds.

- Planting— plant early as soon as soil conditions and temperature are favorable and before the onset of rains. Seed should be planted to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects on Plot 2 only with recommended chemicals (e.g. for aphids and caterpillars) Cypermethrine 50 EC, Decis EC 2,5 or Dursban 48%. For fungicides, Impact can be used.
- Harvesting— Maize not sold to the fresh market should be left in the field until moisture content is 15-20%. Harvested cobs should be dried to approximately 13% moisture. Sufficiently low enough moisture is indicated if it is difficult to crush a few grains between ones teeth. Shelled corn should be dried before placing in secure storage. Maize residues not used for fodder or fuel should be incorporated back into soil during next cropping season.

Passion Fruit/Maracuja (Rwanda)

Important considerations in selecting field sites

- The purple/gray passion fruit performs best in cooler environments at higher altitudes (1200-1800 m) and temperatures (18-25° C), whereas the yellow passion fruit prefers the tropical lowlands (0-800 m and 25-30° C). Vines prefer sheltered locations without extreme temperatures.
- Soils of medium texture with good drainage, rich organic matter and aeration required. Passion fruit is a deep rooting plant, hardpan must be removed. Optimum pH is 5.5-6.0.
- Passion fruit can be intercropped with beans and cabbages. Do not intercrop with cereals, cowpea or creepers (e.g. sweet potato).

1. Seedling Production, Land Preparation and Fertilization

Seedling production—For nursery production, rub seed clean of pulp and dried in shade. Sow seed (1.5-2.5 cm deep) in a shaded seed bed in rows with 10 cm spacing. After seed germinate (2-4 weeks) allow seedling to reach 30 cm length with 3-4 nodes prior to transplanting to the field. Only quality cuttings should be selected.

Land Preparation—Prepare land digging as deep as possible. Incorporate crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, lime (30 kg/are) should be broadcast and incorporated to a 15 cm depth immediately after land preparation and preferably 2 months prior to planting. This application should be sufficient for 3 subsequent cropping seasons (2010 Season B, 2011 Seasons A and B).

Basal Fertilizer Application—Broadcast and incorporate into the soil to a depth of 15 cm the full dose of NPK (17-17-17) (1 kg/are or plot), then level the soil before digging holes (45 cm x 45 cm x 45 cm) every 3m within the row for the seedlings. At the start of the rainy season, seedlings should be place in the hole, water and covered with soil.

Side Dressings—At 6 weeks side dress with urea (0.5 kg/are or plot), mixing the fertilizer into the soil lightly around each plant.

Additional Fertilization— For years 2 and 3 mix 0.68 kg of NPK (17-17-17) into soil around each plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1.0 are)
- Variety—Passiflora edulis (purple/grey)
- Seedling/Cutting rate—16 seedlings/are
- Planting density—1.8-2 m x 3 m. Rows should be approximately 2 meters apart with 3 meters between seedlings/cuttings within rows.
- Other cultural practices: control weeds on Plots 1 & 2. Passion fruit vines require strong trellis support. A single wire trellis of 14 gauge galvanized wire stretched along the top of post (15 cm in diameter x 3 m length and placed at a depth of 0.6 m) placed every 8 meters works well in the field. This model should be adopted for plots 1 and 2 and should be erected when the field is planted. The main shoot and one vigorous lateral should be tied to the wire with string. As vines reach the wire they should be trained in the opposite direction. Maintenance pruning is required to remove all laterals below the wire, damaged branches or branches with no fruits. Laterals along wire are allowed to hang down. Tendrils should be removed to increase aeration and promote light interception. Crop rotation is the best method for controlling soil borne diseases and some pests. Cuttings/Seedlings generated from quality stock helps prevent diseases. Protect vines against birds and rats. Control insects and diseases on Plot 2 only using Rogor. All directions and precautions associated with chemicals should be followed carefully. Rotate to another crop after productive cycle ends (3-4 years) to prevent buildup of soil borne diseases (e.g. nematodes). Purple/grey passion fruit is more susceptible to nematodes than yellow passion fruit. .
- Harvesting---Harvest approximately 8 months after transplanting. Passion fruit for the fresh market should be picked at full color development. For processing, the fruit should be picked at near maturity (shriveled and unattractive). Ripe fruit will store (cold storage) for a limited time.

Soybean/Soja (Rwanda)

Important considerations in selecting field sites

- Optimum temperatures for production range between 22-30° C with a rainfall of 400-500 mm. Soybeans prefer an altitude of < 2000 m and require moist conditions during flowering and pod formation, but dry weather for ripening.

- Soybeans are pH sensitive with the optimum pH being between 6.0-6.5. In acid soils, liming is essential for optimum yields.
- Soybeans can be grown as a sole crop or intercropped with maize, cassava, sorghum, tree crops. Soybeans should be rotated (at least every two years) with maize or other small grains, but should not follow edible beans, rape or sunflowers due to possible disease carryover.

1. Land Preparation and Fertilization

Land Preparation—prepare the land one month before planting. If the soil pH is < 5.5 mix lime (50 kg/are) into the soil to a depth a depth of 15 cm immediately after land preparation and preferably 2 months prior to planting. This application should be sufficient for three subsequent croppings (2010 Season B, 2011 Seasons A and B). Crop residues and composted manure (50-100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the entire dose of DAP (0.5 kg/are or 1.25 kg/plot). If soybeans are grown on a volcanic soil DAP rate should be increased to (80 kg/are or 2 kg/plot). Due to soybean's need for P and available K in most soils, TSP could be a preferable fertilizer source if available and economically feasible.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— Peka 6
- Spacing for sole crop — 40 cm x 10 cm. Furrows/rows should be 40 cm apart with spacing of 10 cm between seeds within each row.
- Planting— apply inoculum (*Rhizobium* sp.) to the seed at a rate of 40 g *Rhizobium* for each 2 kg of seed. Plant early as soon as soil conditions and temperature are favorable and before the onset of rains. Seed should be planted in rows to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases On Plot 2 only control insects with Cypermethrine 50 EC or Rogor as directed. Proper crop rotation will prevent a number of diseases.
- Harvesting— Soybeans should be harvested when most leaves have yellowed. Plants are cut close to the ground and windrowed for drying. After threshing, soybeans should be dried to <12% moisture before storing. Residues not used for fodder or fuel should be incorporated back into soil during next cropping season.

Potato/Pomme de terre (Rwanda)

Important considerations in selecting field sites

- Potatoes primarily grown as a sole crop in cool climates where day time temperatures range between 20-25° C and night time temperatures are below 20° C. Cultivation is concentrated in altitudes between 1200-3000 m.
- Potatoes **must be rotated** with other crops (e.g wheat, maize, rice or legumes). Potatoes **should not** be planted in a field previously planted to potatoes, tomatoes, eggplants, or peppers during the last 3 cropping seasons. Potatoes following cabbage or mustard crops are less susceptible to bacterial wilt and nematodes.
- Potatoes require a well distributed rainfall of 500-750 mm and well-drained soils. Preferred soil pH ranges from 4.8-6.

1. Land Preparation and Fertilization

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, lime (40 kg/are or 100 kg/plot) should be added to Plot 2 via. broadcasting and incorporation to 15 cm depth immediately after land preparation and preferably 2 months prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose of NPK (17-17-17) . Level the soil before digging holes for the seed potatoes.

Side Dressing--Urea should be applied in two equal applications (0.5 g/are or 1.25 kg/plot) when the plants reach 15 cm and at flowering. Urea should be mixed into soil around each plant.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety— Mabondo, Ou Gikungu
- Seedling rate— 20-25 kg/are or 40-62.5kg/plot
- Planting density—75 cm x 30 cm
- Other cultural practices: control weeds on Plots 1 & 2 and earth up at 14 days after planting . Crop rotation is essential for controlling soil borne diseases in potatoes and some pests. Use of certified seeds and resistant seeds helps to control diseases. Control insects and diseases on Plot 2 only using Dursban, Rogor, or Fenithrotrion for pests or Ridomal MZ 68 or Dithane M 45 as fungicides (e.g. powdery mildew). All directions and precautions associated with chemical use should be followed carefully.
- Harvesting---Harvest between 3-4 months after planting. The aboveground biomass (haulm) should be removed 10-14 days before lifting the potatoes. After harvesting the potatoes should dry in the field in heaps for 1-2 weeks at 10-20° C (or in cold storage) under high humidity. All

damaged tubers should be removed before the tubers are sent to market. On farm storage should be in a well-ventilated dark building.

Cassava/Manioc (Rwanda)

Important considerations in selecting field sites

- Optimum temperature for production is 20-30° C with an optimal rainfall of 1000-1500 mm without dry spells. . Cassava is grown to an altitude of 1500 .. Once established, cassava is resistant to severe drought.
- Well drained sandy loam soil is preferred, but cassava can produce reasonable yields on infertile and eroded soils. Optimum pH level is 5.5-6.5, but some cultivars can tolerate pH as low as 4.6 or as high as 8.0. Very fertile soils promote excessive foliage and reduce root yield.
- Bitter cassava varieties must be properly processed to reduce toxic levels of cyanogenic glucoside content (HCN). Sweet varieties can be eaten raw and fresh due to low levels of HCN.

1. Cuttings, Land Preparation and Fertilization

Cuttings-- From healthy plants 8-14 months old, select cuttings 20-30 cm long and 20-25 mm in diameter with 5-8 nodes. Slight pest infection of cuttings can be treated by immersing cuttings in heated water (50:50 hot:cold) for 5-10 minutes just before planting. Cuttings must be planted within 2 days of selection

Land Preparation—Soil should be worked with hoe to a depth of 10-15 cm with incorporation of crop residues prior to fertilization and planting. If water-logging or erosion is a problem mound or ridge the soil (1m x 1m) meter for planting the cuttings.. If land is flat and there is no danger of water-logging, cuttings can be planted on level ground.

Fertilizer Application—One month after planting cuttings side dress with full dose of (10 kg/plot) of NPK (17-17-17) mixing the fertilizer into the soil around each plant. .

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—192/0057 (Cyizere)
- Seeding rate—100 cuttings/are. From healthy plants 8-14 months old, select cuttings 20-30 cm long and 20-25 mm in diameter with 5-8 nodes. Slight pest infection of cuttings can be treated by immersing cutting in heated water (50:50 hot:cold) for 5-10 minutes just before planting. Cuttings must be planted within 2 days.
- Planting density—1 m x 1 m for sole crop. Cutting can be planted vertically, at an angle, or horizontally depending on soil moisture content or soil texture. For dry soils plant cuttings at an angle and cover the larger part with soil. For sandy soils use vertical planting to encourage deeper root growth. Horizontal planting produces a number of thin stems more susceptible to lodging.

- Other cultural practices: Cassava can be intercropped along with cowpea or groundnut in tree crops such as *Leucaena*, *Canavalia* or *Crotalaria*. Control weeds on Plots 1 & 2. To control insects and disease, select only healthy cuttings, plant early in the rainy season, and use resistant varieties if available. Rotate with other crops to prevent buildup of soil borne diseases.
- Harvesting---Harvest starts at 9-12 months and when harvested for urban market are harvested in bulk (not piece-meal as is done for household use). Fresh harvested cassava does not store well and therefore must be peeled, chopped and dried. It can be stored as chips or ground flour under dry conditions.

Irrigated Rice/Riz (Rwanda)

Important considerations in selecting field sites

- Optimal air temperature for growing irrigated rice is 20-37.7° C and optimal floodwater temperature is 21-29° C
- Floodwater is required in large quantities 3-7 days following transplanting and the period between booting to 14 days after heading. Drain fields 10 days before harvest to dry soil and to hasten drying and ripening of rice grains.
- Rotation of irrigated rice with soybeans and green manures during the off season provides benefits for maintaining soil structure and soil fertility and reduces the need for fertilizer nitrogen (N) for the next rice crop.

1. Seedling Production, Land Preparation and Application of Fertilizers

Nursery seedlings—prepare and flood the seedbed 2 weeks prior to sowing. Puddle one week before sowing and prepare a raised nursery bed. Drain the nursery bed the day before sowing. Broadcast between 500-1000 grains/are (equivalent to a seed rate of 50 kg/ha). Keep the seed bed moist. Once the seedlings emerge flood the seedbed to a depth of 1-3 cm depending on the growth of the seedlings. Allow seedling to grow for 14-18 days. One day prior to transplanting, raise the water level to 10 cm to ease uprooting of seedlings.

Land preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to puddling (one day prior to transplanting) and basal fertilizer application. Consideration should also be given to incorporating composted manure (if available) into paddy fields along with crop residues to reduce fertilizer requirements.

Basal Fertilizer Application—Before transplanting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (1 kg/are or 2.5 kg/plot), then level the soil before transplanting the rice seedlings. Flood the paddy with 10-15 cm of water.

Top Dressing--Urea should be split applied in two equal applications (0.75 kg/are or 1.8 kg/plot) at the first weeding and just before panicle initiation (35-50 days after transplanting). Remove floodwater for each topdressing then re-flood.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety— WAT
- Planting density—14-18 day old seedlings will be line transplanted in hills with row and plant spacing of 20 cm x 20 cm. Each hill will have 2 seedlings
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Certified seed and resistant seed can help control diseases. Control insects and diseases on Plot 2 only using Dursban, Dimethoate, or Sumithion/Fenithrothion primarily for pests or , Kitazin, Fernasan, or Orius for fungus. Seed may also be treated with Thiran to increase resistance to fungus. All directions and precautions associated with chemicals should be followed carefully.
- Harvesting---Drain fields 10 days prior to harvesting (110-150 days after transplanting). Cut the rice stems, bundle and transport to threshing facility where final drying to 12% moisture takes place before threshing and storing.

Tomato/Tomate (Rwanda)

Important considerations in selecting field sites

- Optimum temperatures for production is between 20-27° C.
- Tomatoes **must be rotated** with other crops (e.g wheat, maize, orrice) and **should not** be planted in a field previously planted to tomatoes, eggplants, or peppers during the last 3 cropping seasons.
- Tomatoes require well-drained soils and are damaged by water logging. Preferred soil pH is between 6.0-7.0.

1. Seedling Production, Land Preparation and Fertilization

Seedling Production— Before sowing mix 3-5 kg of compost into the raised shaded seed bed. If fungal diseases are suspected, apply fungicides (e.g. Ridomil Gold, Captan), or treat seed with Thiram prior to planting in rows (500 g tomato seed should produce enough seedlings for 100 areas) and lightly covering. Irrigate the bed with fine spray immediately after sowing and during seedling growth. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Ten days prior to transplanting, expose the seedlings (~ 4 weeks old) to 6-9 hours of direct sunlight each day. Twelve hours prior to transplanting, thoroughly water the seedlings.

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.5, lime (20 kg/are) should be added to Plot 2 via. broadcasting and incorporation to 15 cm immediately after land preparation and preferably 2 months prior to planting. Raised beds (1.5 m between furrows) should be used for soils with poor drainage.

Basal Fertilizer Application— Broadcast and incorporate to a depth of 15 cm the full dose (1 kg/are) of NPK (17-17-17) . Level the soil before digging holes for tomato plants.

Side Dressing— The remaining ½ dose of urea (0.6 kg/are or plot) should be side-dressed at six weeks after transplanting. Fertilizer should be worked lightly into soil around each plant. Foliar application of secondary nutrients (Ca and Mg) should be considered on soils with pH< 5.5 if lime wasn't incorporated into Plot 2 at least 2 month prior to planting. Foliar fertilization with micronutrients zinc (Zn), boron (B) and copper (Cu) solutions are reported to increase product quantity and quality but the economics of use remains questionable. .

2. Cultural Practices

- Plot size—10 m x 10 m (1 are) on raised beds
- Variety—Ana or Roma
- Seedling rate— 166 plants/are
- Planting density— For raised beds use 1.5 m (furrow to furrow) with a single row of tomatoes planted in middle of the bed with holes/plants spaced 50 cm apart. For soils not subject to water logging the spacing is 80 cm x 80 cm. Seedlings should be transplanted in the late afternoon in holes. Cover plant root with soil and water base of plant.
- Mulch around each plant
- Stake and string the tomato plants to keep fruit off the ground.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is essential for controlling soil borne diseases and some pests in tomatoes. Use of certified seeds and resistant seeds also helps to control diseases Control pest and diseases on Plot 2 only using Dursban or Rogor (7.5 ml/ 10 liters water) for insects and Dithane M 45 (.2 kg/are) or Ridomal MZ 68 (.35 kg/are) for powdery mildew, alternaria, and anthracnose. All directions and precautions associated with pesticides should be followed carefully. Liming will help prevent blossom end rot due to calcium (Ca) deficiency.
- Harvesting---Tomatoes grown for the fresh market require frequent picking and should be stored in the shade until sorted and graded. Marketable fruits should be packaged properly to prevent injury and reduce water loss. Mature-green tomatoes can be stored 7-10 days in cold storage (13-18° C and 85-90% relative humidity). Tomato varieties design for processing (e.g. Roma) are left on the vine until 85% of the fruit is ripe. If they are picked for whole tomatoes, pick while still firm.

Beans/ Haricot (Rwanda)

Important considerations in selecting field sites

- Optimum temperature for production is 20-25° C between altitudes of 1000-2100 m. Well distributed rainfall between 900-1200 mm is sufficient, but beans growing during the dry season will require up to 50 mm of water per week via. irrigation.
- Well drained, silty loam to heavy clay soils high in organic matter are preferred. Optimum pH level is 5.5-6.5.
- Green beans for the market can be planted at 2-3 week intervals starting in mid-August until the end of February.

1. Land Preparation and Fertilization

Land preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, lime (20 kg/are or 50 kg/plot) should be broadcast and incorporation to 15 cm at least one month (preferably 2 months) prior to planting. This application should be sufficient for 3 subsequent cropping seasons (2010 Season A and 2011 Seasons A and B).

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm depth the full dose of DAP (0.5 kg/are or 1.25 kg/plot) then level the soil for planting.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—SAXA
- Seeding rate—60 kg/ha (0.6 kg/are) for climbing beans and up to 120 kg/ha (1.2 kg/are) for bush beans.
- Planting density—For bush beans use 40 cm x 20 cm for single rows with 40 cm width between rows and 20 cm between seed within row. For climbing beans 4-6 beans are sown together in hills (spaced 1 m apart) or beans are sown in rows 90-120 cm apart with in row spacings of 15-30 cm. Sow beans at a depth of 3-6 cm.
- Other cultural practices: For a pure stand of beans (sole crop) it is preferable to construct slightly raised beds 1 m in width. Beans can be intercropped with maize, sorghum, potatoes, etc. Control weeds on Plots 1 & 2. Climbing cultivars require stakes or trellis up to 2.5 m in height for support. Avoid planting beans near other leguminous crops (e.g. soybean) that may be a source of bean flies. Control weeds on plots 1 and 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Certified seed and resistant seed can help prevent diseases. Control insects and diseases on Plot 2 only using Rogor, Cypermethrine 50 EC or Decis EC 2,5. Rotate with other crops to take advantage of nitrogen (N) fixed by the bean crop .
- Harvesting---Harvest begins at 7-8 weeks after sowing for early cultivars. Beans should be picked every 2-3 days. Climbing beans produce larger yields. Saved beans should be shelled,

dried and stored in an air tight container. Addition of ash/chili mixture to the stored beans can help prevent weevils.

Eggplant/Aubergine (Rwanda)

Important considerations in selecting field sites

- Optimum daytime temperatures for eggplant production are between 25-35° C with night temperatures of 20-27° C. Eggplants tolerate drought and brief excessive rainfall. Productivity is greatly reduced at altitudes > 800 m.
- Eggplant **must be rotated** with other crops (e.g wheat, maize, rice) and **should not** be planted in a field previously planted to tomatoes, eggplants, potatoes, or peppers during the last three cropping seasons.
- Eggplant requires well-drained sandy loam soils and is damaged by water logging. Preferred soil pH is between 6.0-7.0 with an optimum pH of 6.4.

1. Seedling Production, Land Preparation and Fertilization

Seedling Production— Mix 3-5 kg of compost into the shaded raised seed bed. If fungal diseases are suspected, apply fungicides (e.g. Ridomil Gold, Captan) to the seed bed or treat seed with Thiram prior to planting. Seeds are planted in rows 10 cm apart (and spaced so to make transplant removal easy) and lightly covered. Irrigate the bed with fine spray immediately after sowing and during seedling growth. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Six to nine days prior to transplanting, increase seedlings exposure to direct sunlight and reduce watering slightly each day. Twelve hours prior to transplanting, thoroughly water the seedlings.

Land Preparation—Land (raised beds if poor drainage) should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.5, lime (20 kg/are) should be added to Plot 2 via broadcasting and incorporation to 15 cm immediately following land preparation and preferably 2 months prior to planting. Raised beds (1.5 m between furrows) should be used for soils with poor drainage.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose (1 kg/are) of NPK (17-17-17) then level the soil.

Side Dressing— Three weeks after transplanting or just prior to flowering side dress (1 kg/are or 1 kg/plot) with urea. Fertilizer should be worked lightly into soil around each plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1 are)
- Variety—Tengura white

- Seedling rate— 133(raised bed) -266 (without raised beds) plants/are
- Planting density—For raised beds use 1.5 m (furrow to furrow) with a single row of eggplants planted in middle of the bed with holes/plants spaced 50 cm apart is recommended. For soils not subject to water logging the spacing is 50 cm x 75 cm. Seedlings (with 3-4 true leaves) should be transplanted in the late afternoon in holes along the furrow. The eggplant seedling should be plant to a depth where its first true leave is just above the soil surface. Water the base of each plant.
- Mulch around each plant
- Stake and string the eggplant if necessary to keep fruit off the ground.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method forcontrolling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects and diseases on Plot 2 only using Dursban or Rogor for insects and Dithane M 45 or Ridomal MZ 68 for powdery mildew, alternaria, and anthracnose. All directions and precautions associated with pesticides should be followed carefully.
- Harvesting---Harvesting begins 3-4 weeks after flowering. Harvest by hand leaving a short stem attached to the fruit. Eggplant should be firm and free of cuts or scars. Eggplant does not store well and should be marketed immediately after harvest. Fruits are generally sorted by size and color and should be packed carefully for transport. If cold storage exist, eggplant can be stored for 7-10 days at 7-10° C and 90-95% humidity. Do not store below 7° C.

Sweet Peppers (Rwanda)

Important considerations in selecting field sites

- Optimal temperatures for seed germination is 25-30° C, while optimal temperatures for production are 18-30° C. Sweet peppers tolerate a wide range of altitude with rainfall between 600-1250 mm.
- Sweet peppers **must be rotated** with other crops (e.g. *Brassica*, pulses, okra) and **should not** be planted in a field previously planted to tomatoes, eggplants, sweet potatoes or jute during the last 3 cropping seasons.
- Sweet peppers prefer well-drained loamy soils at pH 5.5-6.8.

1. Seedling Production, Land Preparation and Fertilization

Seedling preparation— M ix 3-5 kg of compost into the shaded raised seed bed. If fungal diseases are suspected apply fungicides (e.g. Ridomil Gold, Captan) to the seed bed or treat seed with Thiram prior to planting. Seeds are planted in rows 10 cm apart (and spaced so to make transplant removal easy) and lightly covered. Irrigate the bed with fine spray immediately after sowing and during seedling growth. For better production, seedlings should be transferred to seedling pots

(e.g. paper cups, banana leaf-rolls) at approximately 2 weeks. Protect very young seedlings from extreme sunlight, but increase exposure as seedlings age. Six to nine days prior to transplanting, increase seedlings exposure to direct sunlight and reduce watering slightly each day. Twelve hours prior to transplanting, thoroughly water the seedlings.

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are or plot) prior to fertilization and planting. For plots with soil pH < 5.5, lime (20 kg/are or plot) should be added to Plot 2 via. broadcasting and incorporation to a 15 cm depth immediately after land preparation and preferably 2 months prior to planting. Raised beds (1.5 m between furrows) should be used for soils with poor drainage.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose (1.0 kg/are) of NPK (17-17-17) then level the soil.

Side Dressing—Forty days after transplanting or just prior to flowering side dress with urea. Work fertilizer lightly into soil around each plant.

2. Cultural Practices

- Plot size—10 m x 10 m (1 are)
- Variety— California Wonder
- Seedling rate— 210 plants/are
- Planting density—100 cm x 50 cm. Seedlings (at 8-10 true leaf stage) should be transplanted in the late afternoon. The sweet pepper seedling should be planted to a depth where its first true leave is just above the soil surface. Water the base of each plant.
- Mulch around each plant
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects and diseases on Plot 2 only using Dursban for insects and Ridomal MZ 68 (.35 kg/are) for powdery mildew, alternaria, and anthracnose. All directions and precautions associated with pesticides should be followed carefully.
- Harvesting---Harvesting begins 3-4 weeks after flowering. Harvest by hand leaving a short stem attached to the fruit. Peppers will store well for up to 2 weeks at 10-13 °F.

Democratic Republic of Congo (Kivu Province)

1. Project: CATALIST
2. Objective: Promote market oriented production in the focus regions of DRC-Kivu based on a comparison of farmers' practice to CATALIST best bet technologies and recommendations. These technologies and recommendations are expected to result in maximum economic yields for the producer.
3. Crop-Locations:

Riz (irrigated)	-Ruzizi (South Kivu-planned for Season B)
Riz (rainfed)	-Beni (Kiatenga-Grand Nor)
	-Beni (Graben -Grand Nor)
Mais	-Beni (Grand Nor)
Pomme de terre	-Lubero (Grand Nor)
Blé	-Lubero (Planned for Season B)
Haricot	-TBD (Planned for Season B)
4. Design: The demonstration trial for each group of farmers/producers will consist of two plots (treatments) for comparison. Plot 1 will be the farmer's normal practice and will vary by farmer. For example, if the farmer normally uses manure and saved seed then this plot will be planted using only manure and saved seed. If the farmer typically uses some fertilizer (e.g. potato farmers) in addition to manure, then the plot will include fertilizer. Plot 2 will be planted based on CATALIST recommendations for each crop including inputs ((fertilizers, improved seed, integrated soil fertility management [ISFM] strategies (crop residues, manures, and possibly lime depending on soil pH and crop requirements)) at recommended application rates. Plot 2 should always include incorporation/recirculation of any cereal straw or leguminous leafage not used for animal feed. Plot 2 will also be managed carefully to prevent pest and disease and may require the use of pesticides. Other maintenance activities such as weed control and irrigation for paddy rice should be done in both plots. Plots 1 and 2 should be located side by side (on sloping ground the 2 plots will be arranged on the same contour perpendicular to direction of the slope) with a sufficient grass strip/distance between the plots to reduce pesticide drift or nutrient runoff. For the irrigated rice plots, bunds will have to be of sufficient height and strength to prevent the exchange of floodwater between the two plots for the entire season.

Below in Table 1 is the application rate for fertilizers and other inputs (manure and lime) specific to the plot size (2.5 ares) required for Plot 2 for each crop in DRC-Kivu. Table 2 contains information on plant spacing, number of demonstrations, total area and quantity of seed required for the crops in each commodity value chain. Table 3 contains information on the varieties proposed for use in the demonstration trials for plot 2 which represents CATALIST's recommendations for the best technology package at this point and time. For future demonstration trials, CATALIST will work to identify new varieties (not currently available in the region, but commercially available) that produce better quality crops, higher resistance to disease and insects, and/or shorter duration growing cycles.

Table 1. CATALIST Recommendations for Fertilizer and ISFM Inputs for Plot 2-DRC (Kivu)

Crop/Culture	Plot Size/ Superficie de la parcelle élémentaire (en ares)	Fertilizer Application Rate Dose d'engrais (kg/ha) ^a			Fertilizer Rate per plot/Quantité pour la parcelle avec engrais (en kg)			ISFM Inputs/Autres intrants pour les deux parcelles ^c
		Urée	DAP	NPK	Urée	DAP	NPK	
Rice/Riz (irrigated)	2.5	150	100		3.75	2.5		
Rice/Riz (rainfed)	2.5	100	100		2.5	2.5		Composted manure and 50 kg/are lime pH<5.0
Maize/Mais	2.5	100	100		2.5	2.5		Composted manure and 50 kg of lime pH <5.5
Potato/Pomme de terre	2.5	100		200	2.5		5	Composted manure and 100 kg of lime pH<5.0
Wheat/Blé	2.5	100	100		2.5	2.5		Composted manure and 75 kg of lime pH<5.5
Green Beans/Haricot	2.5		50 ^b			1.25		Composted manure and 50 kg of lime if pH <5.0

^a DAP and NPK (17-17-17) to be basally applied. Urea to be split applied in two top dressings if conditions related to growth stage, growth, and weather conditions are favorable.

^b Higher P rate will be required for volcanic soils (80 kg/ha). TSP fertilizer (if available) may be preferable if economically feasible (TSP cost = or < DAP).

^c Available crop residues (cereal straw or leguminous leafage) should always be incorporated into field when not used for fodder. In addition, composted manure is recommended for most crops. Lime is applied to acidic soils once the pH drops to a level that inhibits crops' response to fertilizers.

5. Monitoring and Evaluation: In order to properly maintain the demonstrations and to promote facilitators' oversight a timeframe for implementation of activities associated with establishment and maintenance of the demonstration plot will be required. In addition, there will be common measurements and activities required for each plot in each demonstration including:

- Planting date (should be the same for Plots 1&2)
- Germination date
- Plant survival rate
- Maintenance (e.g. weeding, irrigation) dates
- Pesticide treatment (dates) for insects or disease treatments (Plot 2 only) as needed. Plots should be checked at least twice weekly for insects and disease
- A brief report on field days for neighboring farmers including information on number of participants, farmers' reactions, and observations.
- Yield sampling

6. Cultivation details by crop can be found in Annex 1.

Table 2. Planting density and quantities of seeds required in DRC Kivu Season A (only)

Crops	Planting density	Number of demonstrations	Total area Plots 1&2 (en ares)	Quantity of seeds
Riz (irrigated)	20 cm x 20 cm	TBD* -Season B	TBD*- Season B	TBD*- Season B
Riz (rainfed)	20 cm x 20 cm	17	85	85
Mais	50 cm x 30 cm	5	25	6.25-25
Pomme de terre	70 cm x 50 cm	6	30	750 seed potatoes
Blé	120 kg/ha , 20 cm x 20 cm between rows	TBD* - Season B	TBD*- Season B	TBD*- Season B
Beans	40 cm x 20 cm	TBD*- Season B	TBD*- Season B	TBD*- Season B

* To be determined (TBD) prior to 2010 Season B

Table 3. Proposed Sites, Varieties, Altitudes and Rainfall for Value Chains-DRC Kivu

Crops	Sites	Variety	Altitude (m)	Rainfall (mm)
Riz (irrigated)	Ruzizi	Ihron, IRAT 112	775-1000	800-900
Riz (rainfed)	Beni-Kiatenga	Suparica ^a	920	1200
	Beni-Graben	Suparica ^a	920	1200
Mais	Beni	Ssalongo ^a		
Pomme de terre	Lubero-Kirumbo	Cruza 8165/19	1700	1500
Blé	TBD ^b	-----	-----	-----
Haricot	TBD ^b	-----	-----	-----

^a Must be purchased from Uganda (NASECO Seeds)

^b To be determined (TBD) prior to Season B 2010

ANNEX 1 (DRC)

Rainfed Rice/Riz (DRC-Kivu)

Important considerations in selecting field sites

- Optimal air temperature for growing rainfed rice is 20-37.7° C.
- Rotation with soybeans and green manures during the off season provides benefits to soil structure, soil fertility and tilth and reduces the amount of fertilizer nitrogen (N) required for the next rice crop.

1. Land Preparation and Fertilization

Land Preparation—Prepare land incorporate lime (20 kg/are or 50 kg/plot) to a depth 15 cm if pH <5.0. Crop residues and composted manure (40 kg/are or 100 kg/plot) should be incorporated at least one month prior to planting. Planting should be done before the onset of rains.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the full dose of DAP (1 kg/are or 2.5 kg/plot), then level the soil before planting.

Side Dressing--Urea (1.0 kg/are or 2.5 kg/plot) should be side-dressed in two equal applications at the first weeding and just before panicle initiation (35-50 days after transplanting). Mix urea into the soil..

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety— Suparica
- Planting density—Row and plant spacing is 20 cm x 25 cm. Seeds are directly sowed. Depending on the variety and associated spacing, seeding rate can vary between 0.5-1.0 kg/are.
- Other cultural practices: control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Certified seed and resistant seed can help control diseases. Control insects and diseases on Plot 2 only using Dursban, Dimethoate, or Sumithion/Fenithrothion for pests and Kitazin, Fernasan, or Orius for fungus. Seed may also be treated with Thiram to increase resistance to fungus. All directions and precautions associated with chemicals should be followed carefully.
- Harvesting---Depending on variety harvest begins 120-150 days after planting. Cut the rice stems, bundle and transport to threshing facility where final drying to 12% moisture takes place before threshing and storing.

Maize/Mais (DRC Kivu -Grand Nor)

Important considerations in selecting field sites

- Optimum temperatures range from 20-30° C with rainfall of 600-900 mm. Maize grows at altitudes > 2100 m but growth maturity days increase considerably above 1500 m.
- Soils for maize production should be well drained, well aerated and moderately deep with adequate organic matter and a pH of 5-8. Optimum pH is 5.0-5.7.
- Maize should be grown in rotation (e.g. wheat, potatoes, soybeans) or intercropped (e.g. beans, cassava) with other crops to prevent buildup of soil borne pests and diseases.

1. Land Preparation and Fertilization

Land Preparation—prepare the land one month before planting. If the soil pH is < 5.0, lime (20 kg/are or 50 kg/plot) should be incorporated into the soil immediately following land preparation. This application should be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Seasons A and B). Crop residues and composted manure (50-100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil to a depth of 15 cm the entire dose of DAP (1 kg/are or 2.5 kg/plot).

Top Dressing—Urea (1.0 kg/are or 2.5 kg/plot) should be side-dressed in two equal splits (1.25 kg/plot) when the crop is knee high and at silking. Urea fertilizer should be mixed into the soils around each plant.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— Ssalongo
- Spacing — 50 cm x 30 cm. Furrows/rows should be 50 cm apart and within row spacing of 30 cm between seeds.
- Planting— plant early as soon as soil conditions and temperature are favorable and before the onset of rains. Seed should be planted in rows to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is the best method for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects on Plot 2 only with recommended chemicals (Cypermethrine 50 EC, Decis EC 2,5 or Dursban 48%). All chemical treatments should follow recommended doses and be handled carefully.
- Harvesting— Maize not sold to the fresh market should be left in the field until moisture content is 15-20%. Harvested cobs should be dried to approximately 13% moisture. Sufficiently low enough moisture is indicated if it is difficult to crush a few grains between ones teeth. Shelled corn should be further dried before placing in secure storage. Maize

residues not used for fodder or fuel should be incorporated back into soil during next cropping season.

Potato/Pomme de terre (DRC Kivu Grand Nor)

Important considerations in selecting field sites

- Potatoes are primarily grown as a sole crop in cool climates where day time temperatures range between 20-25° C and night time temperatures are below 20° C. Cultivation is concentrated in altitudes between 1200-3000 m.
- Potatoes **must be rotated** with other crops (e.g wheat, maize, rice or legumes). Potatoes **should not** be planted in a field previously planted to potatoes, tomatoes, eggplants, or peppers during the last 3 cropping seasons. Potatoes following cabbage or mustard crops are less susceptible to bacterial wilt and nematodes.
- Potatoes require a well distributed rainfall of 500-750 mm and well-drained soils. Preferred soil pH range is 4.8-6.

1. Land Preparation and Fertilization

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (100 kg/are) prior to fertilization and planting. For plots with soil pH < 5.0, lime (40 kg/are or 100 kg/plot) should be added to Plot 2 via. broadcasting and incorporation to a 15 cm depth immediately after land preparation and preferably 2 months prior to planting.

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose (2 kg/are or 5 kg/plot) of NPK (17-17-17), then level the soil before digging holes for the seed potatoes.

Side Dressing--Urea should be side dressed in two equal split applications (0.5 g/are or 1.25 kg/plot) when the plants reach 15 cm and at flowering.

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety— Cruza 8165/19
- Seedling rate—20-25 kg/ha or 40-62.5 kg/plot
- Planting density—70 cm x 50 cm
- Other cultural practices: control weeds on Plots 1 & 2 and earth up at 14 days after planting. Crop rotation is essential for controlling soil borne diseases and some pests in potato crops. Certified seed and resistant seeds help prevent diseases. Control insects and diseases on Plot 2 only using Dursban, Rogor, or Fenithroton for pests and Ridomal MZ 68 or Dithane M 45 for

powdery mildew. All directions and precautions associated with chemicals should be followed carefully.

- Harvesting---Harvest 3-4 months after planting. The above-ground biomass (haulm) should be removed 10-14 days before lifting the potatoes. After harvesting, dry the potatoes in heaps for 1-2 weeks at 10-20° C (or in cold storage under high humidity). All damaged tubers should be removed before the tubers are sent to market. On-farm storage should be in a well-ventilated dark building.

Wheat (DRC- Kivu-may be modified prior to 2010 Season B)

Important considerations in selecting field sites

- Wheat is best adapted to deep, well-drained soils of medium texture and medium-to-high fertility. Wheat will tolerate poorly drained, heavy-textured soils better than other small grains, but may “drown out” in extremely wet areas, and will be more susceptible to diseases under such high-humidity conditions.

1. Land Preparation and Fertilization

Land Preparation—prepare the land at least 4 months before the onset of rains. If the soil pH is < 5.5 lime (75 kg/plot) should be broadcast and incorporated into the soil immediately following land preparation. This dosage should be sufficient for three subsequent cropping seasons (2010 Season B, 2011 Seasons A and B). Crop residues and composted manure (100 kg/are) should be worked into the soil prior to planting.

Basal Fertilizer Application—Broadcast and mix into the soil the entire dose of DAP at a rate of 2.0 kg/are or 5.0 kg/plot. Level the soil.

Side Dressing--Urea should be side dressed at a rate of 1 kg/are or 2.5 kg/plot and mixed into the soil surface 6 weeks after planting .

Foliar Fertilization—Application of Bayfolan (11-8-5) at 4 weeks and just prior to booting may improve wheat quality.

2. Cultural Practices

- Plot size—25 m x 10 m
- Variety— To be determined (TBD)
- Spacing — 20 cm x 20 cm. Furrows/rows should be 20 cm apart and seed dropped in the furrow at 20 cm intervals.

- Planting— with the onset of rain seed should be applied at a rate of 1.2-1.5 kg/are or 3-3.75 kg/plot. Seed should be planted to a depth of 3-6 cm and covered.
- Other cultural practices--control weeds on Plots 1 & 2. Crop rotation is essential for controlling soil borne diseases and some pests in wheat. Use of certified seeds and resistant seeds also helps to control diseases On Plot 2 only control insects by spraying with Cypermethrine 50 EC, Decis EC 2.5, or Dimethoate. For fungicide control use Orius or copper (Cu) based fungicides. Follow all chemical application directions for chemicals carefully.
- Spray foliar feed (Bayfolan [11-8-5]) as directed at or just before booting stage to enhance yield and nutritional content.
- Harvesting— Harvest at approximately 13% moisture. Residues not used for fodder or fuel should be incorporated back into soil during next cropping season.

Beans/ Haricot (DRC Kivu—maybe modified prior to 2010 Season B)

Important considerations in selecting field sites

- Optimum temperature for production is 20-25° C between altitudes of 1000-2100 m. Well distributed rainfall between 900-1200 mm is sufficient, but beans growing during the dry season will require up to 50 mm of water per week via. irrigation.
- Well drained, silty loam to heavy clay soils high in organic matter are preferred. Optimum pH level is 5.5-6.5.
- Green beans for the market can be planted at 2-3 week intervals starting in mid-August until the end of February.

1. Land Preparation and Fertilization

Land Preparation—Land should be properly prepared with incorporation of crop residues and composted manure (40 kg/are or 100 kg/plot) prior to fertilization and planting. For plots with soil pH < 5.0, lime (20 kg/are or 50 kg/plot) should be broadcast and incorporation to 15 cm immediately after land preparation and preferably 2 months prior to planting. This application should be sufficient for 3 additional subsequent cropping seasons (2010 Season B and 2011 Seasons A and B).

Basal Fertilizer Application—Before planting, broadcast and mix into the soil to a depth of 15 cm the full dose of DAP then level the soil for planting

2. Cultural Practices

- Plot size—25 m x 10 m (2.5 are)
- Variety—TBD

- Seeding rate—60 kg/ha (0.6 kg/are) for climbing beans and up to 120 kg/ha (1.2 kg/are) for bush (dwarf) beans
- Planting density—For bush beans use 40 cm x 20 cm for single rows with 40 cm width between rows and 20 cm between seed within row. For climbing beans 4-6 beans are sown together in hills (spaced 1 m apart) or beans are sown in rows 90-120 cm apart with in row spacings of 15-30 cm between seeds. Sow beans at a depth of 3-6 cm.
- Other cultural practices: For a pure stand of beans (sole crop) it is preferable to construct slightly raised beds 1 m in width. Beans can be intercropped with maize, sorghum, potatoes, etc. Climbing cultivars require stakes or trellis up to 2.5 m in height for support. Avoid planting beans near other leguminous crops (e.g. soybean) that may be a source of bean flies. Control weeds on plots 1 and 2. Crop rotation is essential for controlling soil borne diseases and some pests. Use of certified seeds and resistant seeds also helps to control diseases Control insects and diseases on Plot 2 only using Rogor (7.5 ml/10 liters water), Cypermethrine 50 EC or Decis EC 2,5 (5 ml/are). Orius can be used as a fungicide. Rotate with other crops to take advantage of nitrogen (N) fixed by bean crop.
- Harvesting---Harvest begins at 7-8 weeks after sowing for early cultivars. Beans should be picked every 2-3 days. Climbing beans produce larger yields. Saved beans should be shelled, dried and stored in an air tight container. Addition of ash/chili mixture can help prevent weevils.

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