J.3 School Latrine Pilot Project

J.3.1 Contract and Handing Over Letter

(1) Agrrement on School Latrine

An Agreement on a school latrine construction pilot project between JICA Study Team, FFEDA School, PTA, and Munuki Payam

June 26, 2009

Prepared by

Japan International Cooperation Agency's Study Team for JUBA Urban Water Supply and Capacity Development Study in Southern Sudan

(A) JICA Study Team provides the followings during the project period (until June 30, 2009):

1. UNICEF-designed composting latrines (hereafter "LATRINES) including below.
   - A limited starter kit to carry out activities associating with LATRINE operation and management, composting, and gardening
   - Assistance to formulate Pupils' Hygiene Club or any school organization that will govern operation, management and maintenances of the LATRINES and such activities that improve hygiene and sanitation situation of the pupils and the school
   - Information and materials to initiate safe and appropriate operation and management of the LATRINES
   - Assistance to develop education materials about proper use and maintenance of LATRINES and handling composted material
   - Assistance to develop curriculum and initial activity plan regarding hygiene, sanitation and composting
   - Assistance to train teachers and students for practicing hygiene and sanitation measures
   - A rain water harvesting system, which is also connected to the city water supply line, for a hand washing facility

(B) FFEDA School and its students provide the followings during and after the Project period:

1. A space and various resources to construct LATRINES
2. A garden for compost-fed agriculture/gardening
3. School time and teachers for Project activities regarding hygiene and sanitation
4. Means of supports to make, operate, and maintain the LATRINES and students health club (hereafter "WASH Club") activities
5. Develop and train WASH Club, or any other LATRINES management body
6. Initiative and management of a garden to grow plants using composting materials and urine
7. Necessary contributions from PTA and community to keep operating and managing the LATRINES properly

(C) PTA of FFEDA School and community member provide the followings during and after the Project period:

1. Materials, time, money and moral supports to the pupils on students health club activities
2. Money to pay water tariff to UWC
3. Participation to the school activities associating water, sanitation, and LATRINE

From JICA Study team for water To FFEDA School			
Date: June 26, 2009			
Item	Qty	Unit	Remark
6 room Latrine building	1	set	Including an IEC wall painting
Hand washing facility with 2 tanks	1	set	Rain water harvesting
A line to connect water main line	1	set	Water tariff must be paid to UWC
Flip chart easel	1	pc	
Calculators	6	pcs	
Soap	18	pcs	1 has been used for practice
Pencils	36	pcs	2 dz of B, 1 dz of HB
Pencil sharpeners	2	pcs	
Erasers(large)	30	pcs	
Erasers(small)	54	pcs	
Notebooks	10	pcs	1 has been used for practice
Clip boards	15	pcs	8 new, 7 already given
Drawing paper	100	pcs	
Water color paint	60	sets	
Brushes	60	sets	
Small buckets with lids	17	pcs	Blue 14, green 3
Large buckets	10	pcs	Orange 5, Green 5
Rubber groves	10	pairs	L 4, M 3, S 3
Masks	2	packs	
Shovels (large)	10	pcs	Round 5, Squire 5
Wheelbarrows	5	pcs	
Seeds	1	set	
Farming tools	1	set	
ID cards for WASH club members	1	set	
Baseball caps with WASH club logo	30	pcs	Provided to WASH club members
Operation and management manuals	1	set	A binder contains O&M manuals for latrine use, urine fed gardening, and hygiene education.
Hygiene education IEC	4	sets	A set of illustrations of latrine use and hygiene is provided to each classroom.

management

4. Encouragements to the pupils

(D) UWC provides the followings <u>during and after</u> the Project period:

1. A technical support to connect a hand wash facility and tap water pipeline
2. Water mater and water to the hand washing facility

I, DILIGA COSMAS of FFEDA School agree to the conditions stated above and will try to fulfill my obligations.

The date of 27th in the month of June in the year of 2009.

I, MUGHABI FRED, of PTA agree to the conditions stated above and will try to fulfill my obligations.

The date of 27th in the month of JUNE in the year of 2009.

I, Gengon Malig of UWC agree to the conditions stated above and will try to fulfill my obligations.

The date of 27 in the month of June in the year of 2009.

I, MIHO NAKANO, of JICA Study Team agree to the conditions stated above and will try to fulfill my obligations.

The date of 27 in the month of ________ in the year of ________.

Hereby the latrine facility, hand washing facility, tools, and all the responsibilities to manage, maintain, and operate all said items are transferred to FFEDA Basic School.

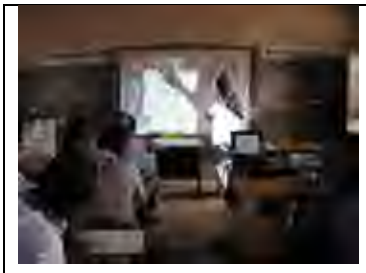
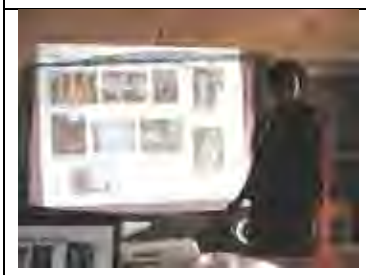
J.3.2 Photos of Activities

1. Pre School Latrine Project Meeting

	Introduced the idea of composting latrine, disadvantages of "western style" toilet system.		A modern toilet was requested to construct at a school Current political and financial capacity is not suitable to operate and manage flushing toilets with a mechanical wastewater treatment system. VIP is not suitable for place like Munuki where groundwater table is very high.
	The attendances favored to composting latrine at the end of the meeting		

2. Toilet Seminar at St. Kizito

		March 27, 2009: Toilet seminar Registration at St.Kizito Church.
		Opening speech of Payam secretary
		A speech from a former Hygiene ministry staff

		Presentation about toilets history, different types of toilets, mechanisms of treatment, & eco-san system.
		A guest speaker from MSF Belgium about cholera.
		Presentation of the Payam secretary and Q&A.

3. PHO PHAST Training

		March 31 PHAST Facilitation practice for Step 1
		April1
		April2 Reviewing Step 1 with PHOs who missed first 3 meetigns

		April 8: PHAST Step 1 activity 2; What health problems and which medical facility of choices.
		April 8
		April 14 Community mapping; first on the ground, then on the paper

4. PHAST Practice to Community

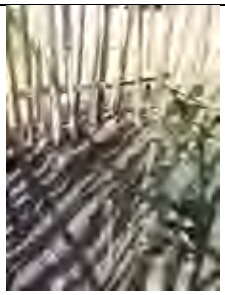
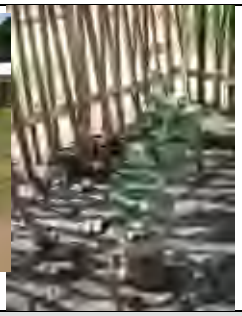
		April 6: Giving PHAST Step 1 to community
		
		

5. Activities at FFEDA Basic School

PTA meeting, April 15, 2009			
	An initiation meeting with the parents of pupils of FFEDA school. The school master introduced about the latrine and PTA's support to following activities		Concepts of a mechanism of latrine, composting gardening, and students governing latrine management body were introduced. Total support and involvement of the parents were asked and agreed.
	Some parents expressed her gratefulness to the project and commitment to support the children and school activities.		
Teacher's training			
Latrine use steps and rules of usage, June 5 and 6 of 2009		School WASH Club member election process workshop June 12, 2009	
 		 	
		Latrine use lecture	
	June 12, 2009 The school inspector, Ms. Elizabeth Loro demonstrate how to explain pupils to proceed a election for class room WASH club members		
June 8 through 12		Latrine use training	June8 -12

	Teaching the pupils of all the levels about the urine diversion latrine and its use		Signing up on a log book
	 		A teacher is explaining to nursery class pupils how to use a latrine (Left). A girl is demonstrating a correct way to squat (center) She also demonstrate how to clean her mess (right)
WASH Club class room representatives election		June 17, 2009	
		Choosing 3 out of 6 girls and 3 out of 6 boys (above) 6 boys and 6 girls candidates in front of peers (left)	
		Casting a ballot, one by one under a teacher's supervision	
Selection of WASH Club leaders/general assembly		June 19, 2009	
			Students who were elected from each class are chosing their leading core members by election.
	President elected		

Gardening spaces			
Flower beds	Experimental pots (1)	Part of the play field will be used for urine fed agriculture	Experimental pots (2)
			
WASH Activities (June 22-26) WASH Club's job		Taking peers for latrine training	
 			
Hygiene promotion picture drawing (June22, 2009)		CHAST/ Good and bad behaviors identification	
 			
Making a story about feaces-mouth transmission path			
 			

Educational mural

Urine diversion composting latrine use process

Urinal and feces holes

Promotion of composting latrine use (Back side)

Image of washing hands (side)

F-diagram: How feaces get into your mouth (side)

Inside of a boy's room

Pictures about water and sanitation

Inside of a girl's room

Handing over celemony

June 26, 2009

J.3.3 Training and O&M Manual

J.3.4 Urine Diversion Composting Latrine Manual

J.3.5 Urine and Compost Fed Gardening Manual

Manuals and References
for
School hygiene and sanitation pilot project
at
FFEDA Basic and pre school
in
Munuki payam
in
Juba, Southern Sudan

June 2009

Prepared
by

JICA Study Team
for
Juba Water Supply and Capacity development Study in the Southern Sudan

Operation and maintenance manual (1)

Urine diversion composting latrine

(1) Structure and Function

Six (6) urine diversion composting latrines were constructed according to the design and specification made by UNICEF and the Government of South Sudan ("Technical guideline and manual of school latrines for field staff and practitioners (Draft)", 2008, UNICEF, the Ministry of Water Resources & Irrigation of Government of Southern Sudan of the Republic of Sudan).

1.1 Urine separation composting latrine

There are two distinct technical approaches to urine separation composting latrines;

· Dehydration: Urine and faeces are managed separately. The deposited fecal matter may be dried by the addition of lime, ash, or earth, and the contents are simply isolated from human contact for a specified period of time to reduce the presence of pathogens. By keeping the faeces dryer, with its natural high ambient temperature in Juba, its decomposing process and pathogens die-off rimes are shorten, thus the final product (composting material) get easier and safer to handle.

· Decomposition (composting): In this process, bacteria, worms, or other organisms are used to break organic matter down to produce compost. The temperature and airflow are carefully controlled to optimize conditions for composting.

- Urines are collected into a urine collection part of a squatting slab, separately from feces. Diverted urine is collected through tubing into a collection container. The container must be emptied as filled up into a larger collection tank, or apply to a root of plants growing in a garden near by in the school.

- Feces are collected in a vault below a squatting slab. As the vault is filled up 3/4 way or less, the latrine is closed for 6 to 12 months. After composting process is completed the vault is emptied and the composted feces are used to produce cash crop or grazing yard to raise live stocks.

1.2 Advantages and Disadvantages:

(+)Advantages:

·It is suitable in rocky areas and here there is a shallow ground water level as it could be constructed above the ground.

·Apart from the amount of water for cleaning of the latrine, there is no need of water for flushing.

·Separately collected urine and composted faeces could be valuable resources (fertilizers) that may be used in agricultural gardening. The end results of agricultural products can be cashed and used for M&O cost of the latrines or needs of the school.

- By separating urine from feces, the moisture and bulk of composting material in a vault are significantly reduced. This results in farther reduction of reaction/decomposition time and longer usage time of a vault, thus easier and less frequent removal of the composted material.
-

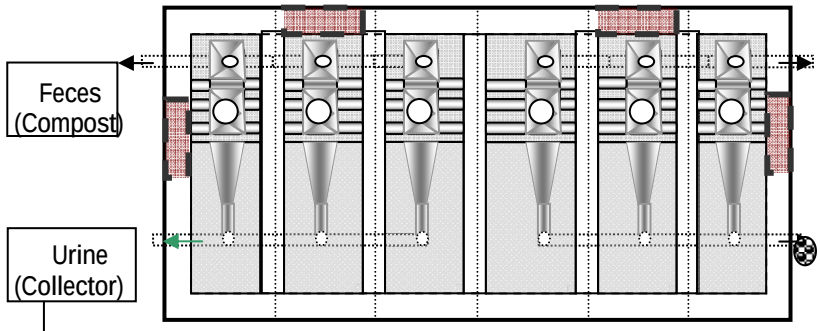
(-)Disadvantages:

·If any liquid (urine or water) is not properly separated, the system will not function properly.

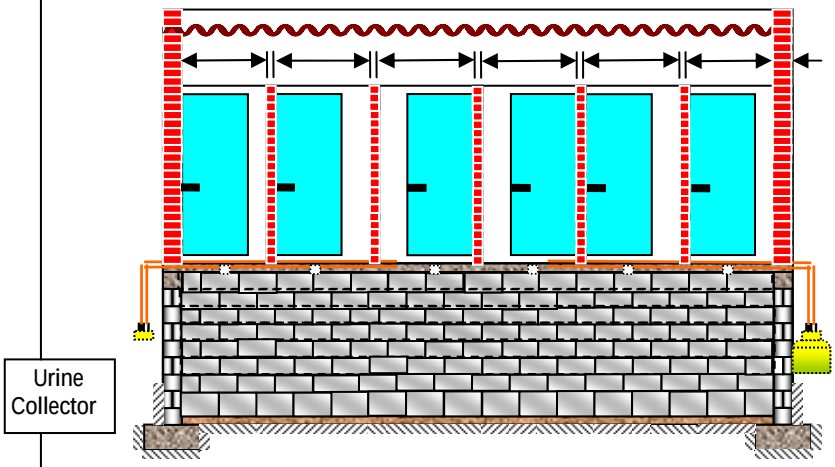
·In areas where handling of human faeces is not accepted, implementation of such type of latrine might be difficult.

- Urine tanks must be emptied every so often depending on the capacity of the tanks and number of users.

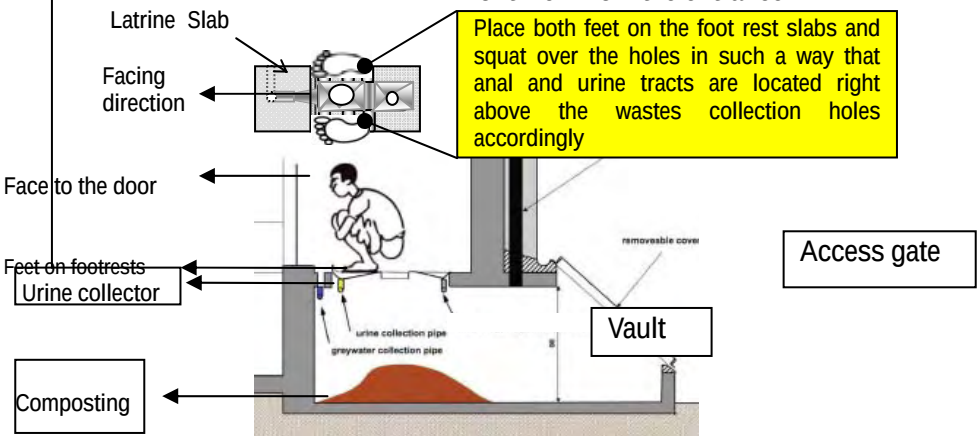
1.3 Structure:



<<Bird view of urine separation composting latrine>>



<<Front view from the entrance>>



<<Side view of the latrine-in-use>>

(2) Roles and responsibility of teachers and students/users

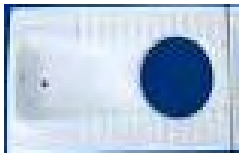
□ Teachers

- Clean and maintain their latrines by themselves; be a good example for pupils
- Teach and supervise the pupils on proper use of the latrines
- Teach and supervise the pupils cleaning and maintaining of the latrines
- Make a log book and a place to keep the keys to the latrines
- Make sure no other people than pupils and teacher use the latrine
- Make sure the latrine would not be abused by community members
- Make sure there is no pressure or threat is imposed to pupils by the parents or other adults
- Make sure the doors to the latrines are locked up and the key is kept with a WASH Club member who is in charge of the key
- Make sure to sign up on a log book before use the latrine; the log book is kept with a member of WASH Club
- Make sure urine is discarded at an appropriate place (Need to be specified)

□ Students and School WASH Club members[1]

- Use a latrine in a proper and responsible manner as taught by the teachers
- Bring ash and cleaning supply from his/her home
- Sign up names of user as the key to the latrine is given
- Check a urine storage tank if it is at "indicator line"; If the tank is filled up to the line empty it out into an appropriate place (need to be decided)
- WASH Club member who keeps the key and log book checks the latrine after it is use as the key is returned.
- Report to WASH Club members who are in charge of latrine issues or to a teacher if a latrine is made dirty or broken or compromised in any other means
- Clean up his/her mess immediately after making the latrine dirty
- Keep a latrine-use-diary of your own and record how you squat and when you made a mess
- A WASH Club member who checks a latrine room makes the user to clean up his/her mess if the room is dirty immediately after it is found
- Bring up issues regarding latrine as he/she noticed to a WASH Club and / or teachers
- Practice clean and proper latrine use at home as well
- Be good keepers of urine-and compost-fed gardens
- Disseminate information about composting latrine and hygiene practice to his/her family members and neighbors

(3) How to use the urine diversion composting latrine

Top view of a toilet slab 			
(1)Close the door, face to the door, and stand over the squatting slab	(2) Place your feet on the foot rests in such way that your anal comes over the center of a larger hole	(3)Squat over the slab. Make sure anal and urinal organs comes over the holes and not to mix them.	(4) After defecate, add handful of ash that was brought from home.

(5) After adding ash and discarding paper that was used to wipe yourself into vault below, check the latrine if you spilled your urine or defecated off the hole and made a mess.
(6-1) If there is no mess, cover the latrine with a lid, close the door, and lock it.
(6-2) If a mess is made, clean with a small broom and dispose into the vault. Do NOT wash it down with large quantity of water. Scrape it with dry materials such as a roll of straws and hard fibers. You can wipe it with a rag. Check again, then close and lock the door.
(7)Log yourself off by signing off on the log book and give the key back to the WASH Club member.
** A student without bringing ash can not use the latrine. He/she must take a bag(s) of ash everyday.

[1] WASH Club should be formed and operational. Formulation and TOR of School WASH Club will be stated later in this document.

Above: An example of a poster that instruct how to use a urine separation composting latrine. This is created in France-phone country and needed to be modified to meet Munuki's context

>>>> THINGS THAT MUST BE PREPARED/PROVIDED BEFORE USING A LATRINE <<<<
By WASH Club:

- ☐ A bucket full of ash for students who need to borrow it, for an emergency need; 10~20L
- ☐ A bucket fill of saw dusts or other organic absorbents; 10~20L
- ☐ Log book, WASH Club Journal
- ☐ Cleaning supplies
- ☐ A Soap at a hand washing facility
- ☐ Solid wastes collection boxes (for female's need)

By Individual Pupil:

- ☐ 1L of Ash (not containing burned plastic or paper with color paints)
- ☐ Wiping paper (No water)
- ☐ Cleaning rag/cloth, paper, cleaning brush/broom,

ALL users must pass the test about latrine use

(4) How to manage and maintain the latrine to be functional and sustained

4.1 Overall procedure

What to use: Absorbents/materials that absorb moisture (e.g. sand, saw dusts, ash, shredded leaves, or dry vegetable matter, keys and pad locks

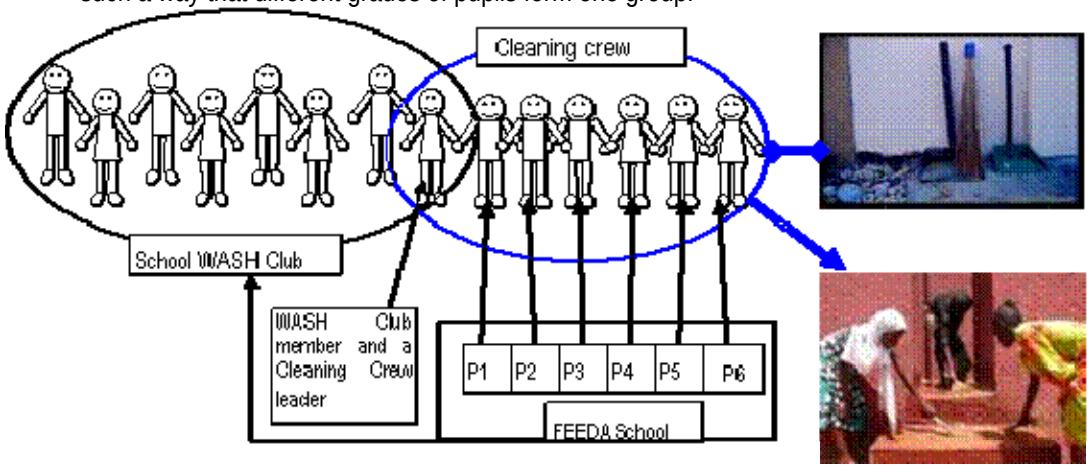
(1) "Initially, a layer of absorbent material (sand and saw dusts) is put in the vault before its commission.
(2) Latrines are made 3 rooms for girls and 3 rooms for boys. 2 rooms. But 1 for boys and 1 for girls are used in 2009 until it is filled up to 3/4 way of the depth. The remaining 4 rooms are closed for future use.
(3)"…after each use, the faeces is covered with ash (or lime, sawdust, shredded leaves or dry vegetable matter) to deodorize the faeces, soak-up excessive moisture and improve carbon/nitrogen ratio, which ensures that sufficient nitrogen is retained to make a good fertilizer.; make sure to discharge urine and feces separately. Also deposit female sanitary products in a solid wastes collection box.
(4) "…when the first vault is three quarters full, it is completely filled with dry powdered earth and sealed. (5) "The contents should be left untouched for at least 3 months* to decompose anaerobically.
(6) "The second vault is used until it is three quarters full and the first vault is emptied by hand.
(7) "The contents in the vault, after decomposition and staying for a year, are used as fertilizer (pp51,MWRI).
*FEEDA school experienced composting phenomenon happened in VIPs during 3 months-holiday time.

4.2 Cleaning procedure

What to use: A small broom, a brush with a handle, a long broom, a dust pan, a mask, a pair of rubber gloves, saw dusts or other dry small particles, a scraper, cleaning paper, rags, a scooper

A) Routine cleaning

- ☐ Form groups of 6 pupils (3 girls and 3 boys) and assign a WASH Club member to be a leader of a group in such a way that different grades of pupils form one group.



- ☐ Each group takes a turn to check and clean the latrine. Report the status of the latrine to the WASH Club leader and its supervising teacher. Bring up issues or suggestions as well.
- ☐ Flushing out the urine convey pipe every weekend. Make sure to change the collection container to one for cleaning from one for gardening use
- ☐ Right after the compost is removed, once a year, when the vault is empty and not used, clean the hole and squatting slab, both in and out sides with water and detergent. Let air dry for a day before start using again.

B) On-demand cleaning; after a latrine user (e.g. a pupil, teacher)made a mess

- ☐ A latrine must be cleaned up as soon as a pupil makes a mess by him/herself.
- ☐ Report the incident to WASH Club member as she/he log off.
- ☐ Wash hands with soap thoroughly

C) Cleaning method

☐ Do NOT use chemical cleaning agents such as OMO and Breach.
☐ Do NOT use excessive amount of water to wash away dirty spots.
☐ Put a mask over mouth (and nose if you wish) and gloves
☐ Sweep the floor of a latrine chamber
☐ Wipe the squatting slab with a wet paper or cloth, use a mixture of disinfectant and water (be careful not to drain water in the holes to vault).
① Use just wet paper or cloth. Do NOT use excess water.
② Insure that no liquids enter the holes in the slab
③ The paper is then drop into the feces vault.
④ Make sure not to wash the slab with chemicals and excess water.
☐ Remove spider combs and other vectors
☐ Wipe the door and walls with a wet rag

>> If it is dirty with human wastes do following also;

☐ Scoop a fecal matter that did not fall into the vault and drop into the hole.
☐ Wipe smear that was made after scooping the excreta with paper. The paper is then drop into the feces vault.
☐ Scrape any heard stuff with saw dusts and a scraper or a short-haired broom
☐ Wipe urine spilled around the squatting slab with paper. The paper is then drop into the feces vault.
☐ Use paper to wipe
☐ After cleaning is finished, wash hands with soap thoroughly
☐ Clean the cleaning tools and place under the sun for UV disinfection and drying

(5) Trouble shooting

Incident	*Solution*	*Things to do*
Feces are mixed in a urine tank	Remove the urine tank and replace it with a new container. The contaminated urine tank is kept under the direct sun light for a week. If there is a dedicated container for contaminated urines, pour and mix with it.	Report to a teacher and WASH Club member immediately when you realize it.
Too much water or urine flow into the vault	Add sufficient amount (more than 1 bucket) of dry/absorbent materials such as saw dusts	Report to a teacher, WASH Club member, composting committee, record the incident on a monitoring notebook
Bad odor	Add enough ash to cover the surface of cumulated excreta in the vault	
Flies	Add enough ash to cover the surface of cumulated excreta in the vault	
Vandalism of facility, naturally deteriorate facility	PTA and WASH committee repair or call for repair the broken part of latrine	Collect manpower, materials and/or money for the repair work
Loss of the key to a lock	A teacher supervising WASH Club breaks the lock. The broken lock must be replaced.	Buy or collect money from PTA to buy and install a replacement lock
Unauthorized person uses the latrines	Have a meeting with WASH Committee, PTA, teachers and the person who are caught and impose penalty/fine.	Collect fine/penalty money (say 100SDG) from the person
Vaults are filled up quicker than anticipated and no more latrine is available	The oldest one of three composts has to be removed from a vault to a composting bin on a school yard, before it can be used functionally.	A composting bin (a stock pile containing box) is constructed. Check the composted material for its maturity.
PTA and parents demand their uses of the school latrines and put pressure on their children/pupils	Hold a WASH Committee meeting and resolve the issue. If they do not agree to the school policy, clocked up all the latrine and no one can use until the problem is solved.	Make an arrangement to have a community meeting
Pupils refuse to clean their own mess	Forbid the pupils to use the latrine and his/her class mates must clean it. He/she can use again after cleaning latrine for 1 week.	Have a class meeting and reconcile. The class comes up with a prevention and counter measures for such incidence in the future.

(6) Latrine Use Training schedule

Task	Responsible person	Objectives	Time
Lecture/class work	Teachers	To know function and sensitivity of the latrine	2 hrs
		To know girls' need: Gender discussion	2hrs
		To learn pupils' responsibility, rules and penalty	2 hrs
Practice	Teachers WASH member	To learn a proper way to use the latrine	2 hrs/class
		To learn a proper way to maintain/clean the latrine	2 hrs/class
Test	Teachers	To confirm level of understandings of a correct way to use latrine	1 hr
Peer education/ follow up	WASH Club member Classroom WASH officer,	To make sure clean latrine	1hr/week
		To make sure proper use of latrine	1hr/week
WASH Club member training	Teachers	To train WASH Club member and classroom officer to know their responsibility, be able to monitor latrine, to use log book, and to enforce rules	1 week
Cleaning crew training	Teachers	To form groups of Cleaning crew	2 hrs
		To practice what to do, how to do	2 hrs/group
Simple maintenance	The sub contractors	To know how to change or repair broken parts of latrine and hand-washing / water harvesting facility	1 week

(7) Monitoring sheet

Monitoring points: Cleanliness, rubbish bin, ash, wiping paper, no spill, no off-defecation, logging in/out, soap at the hand washing facility

Building: No play around the latrine facility, well drainage/no flooding water entering in the vault through the access gates,

Hand washing facility: No drinking, conservation, need to buy water during dry season, soap, alternative way to wash hand with a kettle

Use the revised COGES manual

(8) References

A list a name of the subcontractor and attach the design at the end as appendices.

Reports by GTZ and EcoSanRes.

a-3	*Workshop to verify and improve the manual*
	1 day workshop
a-4	*Simulation of instructions written in the manual= In-class lecture and interactivity*

Students Worksheet, Learning materials

Purpose 1	To learn mechanism of composting latrine		
Purpose 2	To show roles and responsibilities of pupils		
Instruction to teacher	Activity	Tools	Outputs
1.1 Take pupils to the latrine	1 Observe a latrine		
1.2.Show inside of latrine building and explain (1)to face to the door, (2) close the door, (3) where to place the feet, (4)place "urinal tract" above latrine's front hole, (5)position "anal" over the hole on the back	1.2.1. Listen what the teacher tells 1.2.2. Each one of the students demonstrate (1)through (5) 1.2.3. Draw foot prints outlines on the squatting slab's foot rest by chalk, leave them/do not erase 1.2.4. Draw a picture of latrine	Pen, paper, something heard to place a paper for sketch, white chalk	- Be aware of position where to squat - Pictures of latrines
2.1 Ask them (1)how they can keep the latrine clean, (2)what to use for cleaning, (3)how to clean, (4)who and when to clean, (5)how they can prevent the latrine from getting smelly, (6)why flies get attracted to latrines	2.1 Make groups of 5 and discuss about (1)through (6) 2.2 Take a note 2.3 Present their results of the discussions		
3.1. Take a tour to the urine collection tank	3.1. Observe the urine tank		- Pictures of urine tanks
3.2 Ask pupils (1)how many people it needs to fill up the tank, (2)how they can carry the tank to a garden, (3)how they can feed urine to crops/plants, (4)What to do if feces gets mixed with urine tank	3.2 Make groups of 5 and discuss about (1)through (4) 3.3 Have presentations about their conclusions to the issues	Paper /notebook,	- A list of ideas, solution
4.1 In class discussion	4.1 Review of what they have learned in the field		
4.2 Ask pupils to use these pictures they drawn	4.2.1 Pick a picture and ask the pupils to demonstrate how to use it 4.2.2 Ask them to show the class what happen if they use it differently 4.2.3.Ask them to tell the class what responsibilities are required 4.2.4. Ask them what kinds of penalties are appropriate for those who do not observe their responsibility.	Pictures that were drawn in the previous activity Flip chart / sticky paper	- Deepen the knowledge of latrine use
4.3 Ask pupils about maintenance (ref: sec. (a)-2-(5); "Trouble shooting")	4.3.1. Make groups of 5 4.3.2. Ask each group to come up with (1)what kind of problems can happen? Physical damage? (2) how can it be prevented? (3)what is required to prevent it? 4.3.3. Present the results of discussions	Flip chart / sticky paper	- A matrix of problem-solution
4.4 Game	4.4.1 Ask the pupils to draw pictures that they have dropped in latrine before (including things that are not supposed to add to latrine) 4.4.2. Ask the pupils to draw pictures that are found in road side trash 4.4.3 Ask the pupils to draw pictures	Pen, paper	Game material

	of house hold trash		
	4.4.4 Make two groups and line up on the both ends of the class room 4.4.5 Place all the pictures in between the two groups 4.4.6 Ask them to start picking a picture that can not be through in the latrine; start from one pupil in the right. When she/he comes back to the line with a picture, next one runs to pick up another picture and comes back to the line, and repeat this until all are done. Which group was faster than another? Did they pick up right pictures? Count the right pictures and compare the numbers.		

Operation and maintenance manual (2)

Hygiene and Sanitation

(b)	Hygiene and Sanitation Manual
b-1	*Make an outline of curriculum*
	(1) Hygiene and sanitation; Basics, Importance, Prevention of diseases
	Use of Training material from COGES program
	(1.1) Basics
	Personal hygiene □ Cutting finger nails □ Washing hands □ Washing face as wake up □ Regular bathing □ Brushing teeth after meals □ Diarrhea prevention practice
	Public health □ Get immunized □ Use and clean a latrine □ Clean environment in your community, around your household □ Cover your mouth when you sneeze or cough □ Do not open your mouth when you are chewing foods □ Cholera prevention practice
	Core messages of what to teach □ F-diagram: Finger, Feces, Food, Field(Soil), Fluid(water, surface runoff), Fly □ Washing hands with a soap before preparing foods, eating, clean baby's bottom/changing diaper, □ Keep clean and hygienic status court yard, house, dishes, latrine, and body □ Dry the washed dishes and cooking utensils with cloth and keep off from dusts □ No dipping a unclean or used cup into water jug/vase/container □ Cover food, water container, latrine hole □ No open defecation, if do so cover it with soil □ "Cook it or peal it or leave it"
b-1	(1.2) Importance>> Have a group discussion session in a class. The bellows are examples. Keeping practicing hygiene and sanitation counter measures is important because: □ You feel better, do not get sick □ Your family and neighbors also stay healthy □ Less worry for your parents □ Cut medical cost (funeral cost), more money can be spent for education and healthy food □ Keep attending school and pursuit higher degree that helps get a high-pay job □
b-1	(1.3) Prevention of disease, practice>> Make a skit and discuss what an individual can do, what can not do and need a bigger help? What help do you need? The skit contains themes stated below. □ Personal level: Personal hygiene practice >> Discuss examples □ Family level: Food preparation, cleanness of house, health of care-givers (typically a mother), installation and maintenance of latrine, clean drinking water □ Community/Payam level: Community environmental hygiene, no groundwater contamination by neighbor's pit latrine & open defecation, □ CES/GOSS level: Law enforcement and imposing a penalty to the people who violate a code of law to protect public health
	(2) Composting latrine>> Lecture hygiene and sanitation aspect of urine diversion composting latrine
	(2.1) Mechanism Faeces contain disease-causing organisms called pathogens to a much higher degree than urine. Therefore, it is important to avoid cross-contamination between urine and faeces. Compared to conventional mixed systems, source-separation of faeces and urine in toilets will result in: · less volume of material requiring sanitization; · reduced odor and fewer flies; · lower risk of pathogens leaking from the system; and · safer handling.
Make a skit	(2.2) Process >> Understanding this process requires a knowledge of high school science. A teacher has to explain the terms in such way that pupils can understand.

	Pathogens are reduced over the time by (1)changing temperature, (2)changing in pH, (3)changing in moisture content, (4) time (die off time/natural life time of pathogens), (5)other predator organisms that do not exist in human intestine, (6)harsh environment >> Make a skit by using the analogy below. For example, these can be told that; There are small bugs living in your body. The bugs are so small that you can not see in your eyes but only microscope can. There bugs can not live outside of your body; your body is very comfortable and have enough food always even you feel hungry. These bugs can cause trouble some time in your stomach. A new bug that is very rebel to your body can also invade your body through your dirty hands or dirty food. This kind of bug make you sick soon after it gets in your body. Both bugs, already in you and coming from outside can be pooped out. When they are pooped out, the new environment is very hash and difficult to live for the bags. Imagine yourself in cold season without clothe, hot season without a shade, rainy season without an umbrella, under river and almost drawn, when you are surrounded by very mean people… it was difficult for you and uncomfortable, wasn't it? These bugs experience such and if they stay too long in such environment they die.
	(2.3) Products >>Feces: Composted feces in an appropriate manner contain no or negligible amount of harmful organisms. Composting materials is on the other hand, is a rich in nutrients and humus that enrich soil texture and improve condition. Faeces are concentrated and rich in phosphorus, potassium and organic matter. >>Urine: Urine is very rich in nitrogen, phosphorous, and potassium that grow plants and vegetables larger and tasty. Urine free from cross contamination contains no pathogens unless the hosts/human has virus infection.
	Reference: Urine separation composting latrine is closing the nutrient and water cycles. Nutrients from human excreta should be returned to the soil to fertilize crops. Safe processing of the urine and faeces into fertilizer is described in EcoSanRes Fact Sheet 5. Keeping urine and faeces separated at the source simplifies safe processing and handling of excreta. Urine separation composting latrine and agriculture In order to ensure sustained soil fertility and ample harvests, the soil in the cultivation fields needs to be replenished with nutrients and soil-improving material. There are several ways to add nutrients to the soil and to increase its water-holding and buffering capacities. In large-scale commercial agriculture this is mainly achieved by the application of commercial fertilizers. Alternative approaches include crop rotation, slash and burn techniques and the reuse of nutrients and soil-improving products from decomposed plants, animal manure and human excreta. Human food contains considerable amounts of nutrients originating from plants. Only minute amounts of the plant nutrients are absorbed by and retained in the growing human body – the remainder leaving the body as excreta. The products of ecological sanitation, urine and faeces, are in many ways well suited for use as fertilizers. They contain all nutrients essential for crops. The fertilizing effect of urine, just as that of chemical fertilizers, is greater if the soil contains at least some organic matter. Urine is nutrient-rich and faeces are high in organic matter content. They should be used in combination with each other, though preferably not at the same time. Sanitizing human excreta Human faeces contain bacteria, viruses and other pathogens and can be harmful to humans and the environment. However, by handling them according to the hygiene guidelines, the risks associated with reuse of excreta are minimized. Urine: The urine fraction is normally free from pathogens when leaving the body. However, urine can be contaminated by feces. When single households use their own urine as a fertilizer, there is no need for storage prior to application. The last application should be made at least one month prior to harvesting. Faeces: The fecal fraction of excreta must always be sanitized before use as a fertilizer, to prevent transmission of disease. Guidelines on how to sanitize faecal matter are found in Schönning and Stenström (2004), or EcoSanRes Factsheet 5. Fertilizing with urine Urine is a high quality, low-cost alternative to commercial fertilizers. It is especially rich in nitrogen and also contains substantial amounts of phosphorus and potassium. The fertilizing effect is rapid and the nutrients are best utilized if the urine is applied prior to sowing and up until two-thirds of the period between sowing and harvest. It can be applied pure or diluted. To avoid odor, foliar burns and the loss of ammonia, the urine should be applied close to the soil and incorporated into the soil as soon as possible.

Table 1. Pathogens that may be excreted in urine and the importance of urine as a transmission route

Pathogen	Urine as a transmission route	Importance
Leptospira interrogans	Usually through animal urine	Probably low
Salmonella typhi and *Salmonella paratyphi*	Probably unusual, excreted in urine in systemic infection	Low compared to other transmission routes
Schistosoma haematobium (eggs excreted)	Not directly but indirectly, larvae infect humans via freshwater	Need to be considered in endemic areas where freshwater is available
Mycobacteria	Unusual, usually airborne	Low
Viruses: CMV, JCV, BKV, adeno, hepatitis and others	Not normally recognized other than single cases of hepatitis A and suggested for hepatitis B. More information needed	Probably low
Microsporidia	Suggested, but not recognized	Low
Venereal disease causing	No, do not survive for significant periods outside the body	-
Urinary tract infections	No, no direct environmental transmission	Low

Ref "Guidelines on the Safe Use of Urine and Faeces in Ecological Sanitation Systems". SEI (2004), pp4

Table 4. Physicochemical and biological factors that affect the survival of microorganisms in the environment

Temperature	Most microorganisms survive well at low temperatures (<5°C) and rapidly die off at high temperatures (>40-50°C). This is the case in water, soil, sewage and on crops. To ensure inactivation in e.g. composting processes, temperatures around 55-65°C are needed to kill all types of pathogens (except bacterial spores) within hours (Haug, 1993).
pH	Many microorganisms are adapted to a neutral pH (7). Highly acidic or alkaline conditions will have an inactivating effect. Addition of lime to excreta in dry latrines and to sewage sludge can increase pH and will inactivate microorganisms. The speed of inactivation depends on the pH value, e.g. it is much more rapid at pH 12 than at pH 9.
Ammonia	In natural environments, ammonia (NH_3) chemically hydrolysed or produced by bacteria can be deleterious to other organisms. Added ammonia-generating chemical will also facilitate the inactivation of pathogens in e.g. excreta or sewage sludge (Ghigletti *et al.*, 1997; Vinnerås *et al.*, 2003a).
Moisture	Moisture is related to the organism survival in soil and in faeces. A moist soil favours the survival of microorganisms and a drying process will decrease the number of pathogens, e.g. in latrines.
Solar radiation/ UV-light	UV-irradiation will reduce the number of pathogens. It is used as a process for the treatment of both drinking water and wastewater. In the field, the survival time will be shorter on the soil and crop surface where sunlight can affect the organisms.
Presence of other microorganisms	The survival of microorganisms is generally longer in material that has been sterilized than in an environmental sample containing other organisms. Organisms may affect each other by predation, release of antagonistic substances or competition (see Nutrients below).
Nutrients	If nutrients are available and other conditions are favourable, bacteria may grow in the environment. Enteric bacteria adapted to the gastrointestinal tract are not always capable of competing with indigenous organisms for the scarce nutrients, limiting their ability to reproduce and survive in the environment.
Other factors	Microbial activity is dependent on oxygen availability. In soil, the particle size and permeability will impact the microbial survival. In soil as well as in sewage and water environments, various organic and inorganic chemical compounds may affect the survival of microorganisms.

Ref "Guidelines on the Safe Use of Urine and Faeces in Ecological Sanitation Systems". SEI (2004), pp13

Application rates for urine

Urine is a by-product from the body's function of balancing liquid and salts, and the amount of urine therefore varies with time, person and circum-stances. The average person produces about 500 litres of urine per year. However, urine volume is not a good indication of nutrient content. It is better to calculate the application rates based on the amount of urine produced per person per day.

If available, local recommendations for commercial mineral fertilizers, urea or ammonium, can be translated to the use of urine. The nitrogen (N) concentration of urine should be analyzed. Otherwise it can be estimated at 3-7 g N per litre. If no local recommendations can be obtained, a general rule of thumb is to apply the urine produced by one person during one day (24 hours) to one square metre of land per growing season (crop). The urine from one person will thus be enough to fertilize 300-400 m2 of crop per year and even up to 600 m2, if dosed to replace the phosphorus removed by the crop.

For most crops, the maximum application rate before risking toxic effects is at least four times the dose above.

Fertilizing with faeces

The total amount of nutrients excreted with faeces is lower than with urine, and the nutrients are not as easily accessible for plants. However, faeces are concentrated and rich in phosphorus, potassium and organic matter.

Sanitized faeces should be applied prior to planting or sowing as the high phosphorus content is beneficial for root formation of young plants. The faecal matter should be within reach of the plant roots but it should not be the only growing medium. The faeces should be thoroughly mixed in and covered by soil before cultivation starts. If there is a limited amount of faeces fertilizer, it can be applied in holes or furrows close to the planned plants to capitalize on this valuable asset.

Application rates for faeces

The application rate of faeces can be based on local recommendations for the use of phosphorus-based fertilizers and analysis of the phosphorus content of the faecal product. This gives a rather low application rate, and the improvement of the crop due to the added organic matter is hard to distinguish. However, faeces are often applied at much higher rates, at which the structure and water-holding capacity of the soil are also visibly improved. Organic matter and ash are often added to the faeces during collection and processing. These additions will improve the buffering capacity and the pH of the soil, which is especially important on soils with low pH.

The average person produces around 50 litres of faeces each year. This amount of faeces will fertilize 1.5 – 3.0 m2 of crop if the application is made according to organic content. If application is instead based on phosphorus content, it will be enough to fertilize 200-300 m2.

Local adaptations and knowledge gaps

These guidelines should be adapted to local conditions. Agricultural systems vary, as does human behaviour in different cultures. There is a lack of documented research in the area of using urine and faeces as fertilizer. However, these products have been used in agriculture since ancient times, and there is considerable un-documented knowledge based upon practise.

More information would be useful, especially in the following areas:

- nutrient effects of excreta on crops and soil;
- application techniques;
- efficiency of storage of urine in soil; and
- simple and resource-efficient sanitation techniques for faeces.

(All above are quoted from "EcoSanRes Factsheet 6", May 2008)

Estimated excretion of nutrients per capita in different countries (from Jönsson & Vinneråas, 2004)

Country		Nitrogen kg/cap, yr	Phosphorus kg/cap, yr
China	total	4.0	0.6
	urine	3.5	0.4
	faeces	0.5	0.2
Haiti	total	2.1	0.3
	urine	1.9	0.2
	faeces	0.3	0.1
India	total	2.7	0.4
	urine	2.3	0.3
	faeces	0.3	0.1
South Africa	total	3.4	0.5
	urine	3.0	0.3
	faeces	0.4	0.2
Uganda	total	2.5	0.4
	urine	2.2	0.3
	faeces	0.3	0.1

References

Jönsson, H., Richert Stintzing, A., Vin-neråas, B. and Salomon, E. 2004. Guidelines on the Use of Urine and Faeces in Crop Production. EcoSanRes Publication Series. Report 2004-2. Stockholm Environment Institute: Stockholm, Sweden. Available from www.ecosanres.org

Jönsson, H. and Vinneråas, B. 2004. Adapting the nutrient content of urine and faeces in different countries using FAO and Swedish data. In: Ecosan – Closing the loop. Proc. 2nd Intern. Symp. Ecological Sanitation, April 2003, Lübeck, Germany. p 623-626. (www2.gtz.de/ecosan/ download/ecosan-Symposium-Luebeck-session-f.pdf)

Schönning, C. and Stenström, T.A. 2004. Guidelines for the Safe Use of Urine and Faeces in Ecological Sanitation Systems. EcoSanRes Publication Se-ries. Report 2004-1. Stockholm Envi-ronment Institute: Stockholm, Sweden. :Jönsson, H. et al. 2004. Guidelines on the Use of Urine and Faeces in Crop Production. EcoSanRes Publication Series. Report 2004-2. Stockholm Environment Institute; Stockholm, Sweden. Available from www.ecosanres.org

b-1	*(3) Urine and compost fed school gardening*
	(3.1)Types of plants

	Plants that are favorable in Juba ➢ Maize, Some peas, Sorghum, Cassava ➢ Fruit trees ➢ Non human consumption: pastures, flowers (3.2) Make a school gardening plan ➢ Composting latrine management ➢ Timing, who does what, ➢ Composting cycle ➢ Growing cycle of each plants ➢ School activity cycle ➢ Local calendar/ farming cycle ➢ Post harvest plan ➢ Marketing/ distribution/ sales plan ➢ Problems identification and analysis (3.3)Make a connection with local farmers, FAO, and JICA income-generation project for further assistance ➢ Technical supports; skills to take care of a plant/gardening ➢ Material support; seeds distribution ➢ Knowledge support; to know about farming, cultivation, marketing, maintenance of urine and composting-fed agriculture ➢ Visit local farmer to learn traditional farming and his experiences
b-1	*(4)Hygiene promotion activities; songs, pictures, skits, presentation*
	□ PHAST -> CHAST ➢ *Alter PHAST to fit level of capacity of pupils; "CHAST".* ➢ *Use full scale PHAST and identify items that can be understood by children* ➢ *Reduce of alter the items to be more suitable to pupil's behaviours* ➢ *Make pictures by the teachers or pupils* ➢ *Train WASH Club members to do CHAST* ➢ *WASH Club member use CHAST to promote desirable hygiene and sanitation practices and behavior change in school* ➢ *CHAST is given to children who do not attend school, to the pupils in other schools, at church*
	□ Songs, Pictures, Skits are created for each theme that are discussed at Section 2.0 (b-1) (1.1) "Hygiene and sanitation basics". ➢ Chose pupils, voluntary or by nominate, to form groups that work on songs, pictures, and skits ➢ Have them chose theme to create each art form ➢ Assign one teacher for each group to help them create and practice ➢ Show their results on June 21 to the school and PTA ➢ Perform songs and skits on "latrine commission day", June 27, 2009.
b-2	*Make a schedule to formulate a lesson plan for each curriculum*
b-3	*Make lesson plans and lists of materials for both teaching and learning*
b-4	*Give a lesson to the pupils next day and revise the lesson contents*
b-5	*Create teaching and learning materials or alter those provided by JICA*

(c)	WASH Club manual	
c-1	*Study and revise the revised-COGES manual to meet local need*	
c-2	*Make an activity plan for the student body at teachers' level for one academic year cycle*	

Activities	Outputs: Expected results	Timeline/schedule				Responsible person	Implementing person	Inputs
		1/4	2/4	3/4	4/4			

Operation and maintenance manual (3)

Urine and compost fed gardening

(d) Urine& compost-fed gardening

d-1

□ *Guideline, benefits, safety of handling composted material and urine*

Sited from: EcoSanRes is funded by the Swedish International Development Cooperation Agency (Sida) EcoSanRes Factsheet 5 May 2008

(1) Benefit

□ Improving health condition by isolating, naturalizing, and detoxicating of human wastes
□ Improve soil condition by increasing humas and enriching nutrients in the soil
□ Reducing pollutants and health hazardous, protection of groundwater/drinking water
□ Producing nutrients/organic fertilizer to the plants, enhancing agricultural production
□ Producing nutrient rich crops/plants

(2) A summary of protection measures

Table 3. Potential transmission routes related to dry toilets and the use of excreta with simple technical and behavioural measures to limit exposure and minimize risks.

Area or procedure leading to pathogen exposure	Transmission route	Technical measure	Behavioural measure
Toilet	Direct contact; transport to groundwater; environmental contamination	Water for hand washing available; elevated collection chamber; lined collection chamber (no seepage to groundwater or environment)	Washing hands; keeping toilet area clean
Primary handling – collection and transport	Direct contact	Ash, lime or other means of reducing microorganisms at toilet; informed persons collecting and transporting excreta	Wearing gloves; washing hands; addition of ash, lime or other means of reducing the microbial content during use
Treatment	Direct contact; environmental contamination	Suitable choice of location; treatment in closed systems; information signs in place	Wearing gloves and protective clothing; washing hands; avoid contact in treatment areas
Secondary handling – use, fertilizing	Direct contact	Informed farmers reusing excreta; special equipment available	Wearing gloves; washing hands; washing the equipment used
Fertilized field	Direct contact; transport to surface and groundwater	Working excreta into the ground; information and signs	Avoid newly fertilized fields
Fertilized crop	Consumption; contamination of kitchen	Choice of suitable crop	Proper preparation and cooking of food products; cleanliness of kitchen surfaces and utensils

Ref "Guidelines on the Safe Use of Urine and Faeces in Ecological Sanitation Systems". SEI (2004), pp9

(3) Guideline of safe and sanitarily sound use of feces and urine

Urine separation composting latrine is closing the nutrient and water cycles. Nutrients from human excreta should be returned to the soil to fertilize crops. Urine is diverted from faeces in eco-toilets, and reused as fertilizer. Faeces potentially contain pathogenic micro-organisms, and need to be sanitized before use as fertilizer.

Pathogens in excreta

Faeces contain disease-causing organisms called pathogens to a much higher degree than urine. Therefore, it is important to avoid cross-contamination between urine and faeces. Compared to conventional mixed systems,

source-separation of faeces and urine in toilets will result in:

- less volume of material requiring sanitization;
- reduced odour and fewer flies;
- lower risk of pathogens leaking from the system; and
- safer handling.

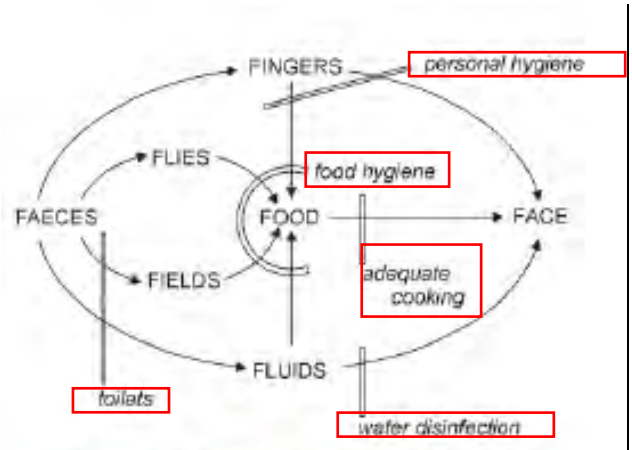


Figure 1: Barriers required to prevent the spread of diseases and pathogens

Organisms that can cause disease include viruses, bacteria and parasitic protozoa, as well as hookworms and other parasitic helminths. Some may lead to severe illness or even death. Others may not be the direct cause of any symptoms but could still lead to diarrhoea, malnutrition or increase the risk of other infections for the infected individual.

In some cases the pathogens can survive for long periods outside the human body and in other cases they are readily destroyed. Factors such as heat, pH, moisture, solar radiation/UV-light, nutrient availability and presence of other microorganisms affect survival. To avoid the risk of being exposed to pathogens it is important to reduce contact with the excreta, and to decrease the number of pathogens in the material. Pathogens such as protozoa and viruses will decrease naturally since they are not able to multiply outside the host, but bacteria may continue to multiply under favourable conditions. As there is currently no ideal indicator organism to ensure the quality of the excreta, the guidelines focus on treatment methods where different process parameters can be recorded.

Primary treatment of faeces

The purpose of primary processing is to reduce the volume and weight of faecal material to facilitate storage, transport and secondary treatment, and to make further handling safer. This process takes place where the faeces are being deposited, either in or under the toilet. Usually the containment period is 6-12 months, depending on the size of the collection chamber. During this phase, pathogen levels will be reduced as a result of storage time, decomposition, dehydration, increased pH, and the presence of other organisms and competition for nutrients.

Storage and Desiccation: Urine is directed away from the faeces to keep the processing chambers dry and the volume small. Ash or lime is added after defecation to lower the moisture content and to raise the pH-level, thus creating unfavourable conditions for pathogens. Cellulose-containing materials like rice husks or sawdust can also be used as a compostable desiccant. Material is usually kept for 6-12 months before secondary treatment. Reaching low moisture levels is highly climate dependent and the material will not always be dry enough for pathogens to be inactivated even if urine is diverted. Faeces are kept separate from both urine and water. By ventilation and the addition of dry material, the pathogen levels will gradually decrease. The use of solar heating can further increase pathogen die-off.

Alkaline treatment: the addition of wood ash or lime will reduce the number of pathogens due to the elevated pH. This treatment also reduces odour and the risk of attracting flies to the toilet.

Secondary treatment of faeces

The purpose of secondary treatment is to make human faeces safe enough to return to the soil. Secondary processing includes high temperature composting, chemical addition of urea and longer storage times. Incineration is used if a completely sterile end product is needed.

Thermal composting: pathogens are destroyed if the compost is kept at an operational level of at least 50°C for 7 days. Addition of bulking material to the faeces is necessary to reach thermophilic temperatures and co-composting with organic house-hold waste is an option. A crucial part of the treatment is the number of turnings needed for all material to be evenly heated and that further maturation of the compost is allowed.

Alkaline treatment: the addition of urea, ash or lime to the faeces will help eliminate the pathogens by elevating both the pH and the level of ammonia. A pH of over 9 for at least 6 months will kill most pathogenic organisms. At a higher pH, shorter time periods could be recommended.

Addition of chemicals is mainly an option in large-scale systems involving trained personnel.

Storage: in areas where ambient temperatures reach up to 20°C, a total storage time of 1.5 to 2 years will eliminate most bacterial pathogens and will substantially reduce viruses and parasites. At higher ambient temperatures, storage times could be shortened to around 1 year.

Incineration: this can be an option as it will ensure that all pathogens and parasites are destroyed, but some nutrients will be lost during the incineration.

Composting systems

Human faeces, or faeces plus urine, are deposited in a chamber along with organic household and garden waste,

and bulking agents such as straw, wood shavings or twigs. A variety of organisms break down the solids into humus. Temperature, air-flow, moisture, carbon materials and other factors are controlled to vary-g degrees to promote optimal conditions for decomposition. After about 6-8 months (Winblad and Simpson-Hebert, 2004), the material is usually moved to a site for high-temperature composting as secondary treatment.

In a soil-based composting system, faeces, or faeces plus urine, are deposited in a chamber together with a liberal amount of ordinary soil and sometimes wood ash as well. Most pathogenic bacteria are destroyed within 3-4 months (Winblad and Simpson-Hebert, 2004) as a result of competition with soil-based organisms and unfavourable environmental conditions. Secondary treatment is as above, or as further composting storage in shallow pits for an additional 12 months. Due to UV-radiation, dryness and competition with other soil organisms, the amount of pathogens is decreased.

Treatment of urine prior to use as fertilizer

Contamination of urine with faeces considerably increases the need for urine sanitization. The recommended treatment of urine for large-scale systems is storage. Storing at ambient temperature significantly decreases the number of pathogens in the urine. Recommended storage time at 4-20°C is between one and six months, depending on the type of crop to be fertilized. For urine that is significantly contaminated a longer storage time and/or a higher temperature is recommended. The urine should preferably be stored undiluted to provide a harsh environment for pathogens, and in a sealed container to prevent loss of nitrogen.

When single households use urine as a fertilizer, there is no need for storage prior to application. The only guidelines given are that the crop is intended for the household's own consumption, and that the last application is made at least one month prior to harvesting. The risk of transmission of disease via urine-fertilized crops is generally lower than between family members.

Practical recommendations on reuse

Urine should be applied close to the ground to avoid aerosol formation. The urine should thereafter be incorporated into the soil, either mechanically or by subsequent addition of water. Separate equipment should be used for the transportation of un-sanitized faeces and for the treated product.

Treated faeces should be worked well into the soil, and not left on the surface. Treated faeces should not be used for vegetables, fruit or root crops that will be consumed raw. Precautions such as wearing gloves and thorough hand washing should be followed by the person handling the excreta.

A period of at least one month between application and harvest is recommended both for urine and for treated faeces. This will further reduce the risk of pathogens due to microbial activity in the soil, UV-radiation from the sun, and desiccation. This one month period also is needed for the crops to utilise the nutrients.

Local adaptations

Both physical conditions, e.g. climate and topography, and cultural aspects need to be considered when setting up an ecosan project. Different cultural and religious beliefs may influence the whole system, including the attitudes towards the use of excreta products. To achieve a well-functioning system, it is necessary that the users accept the procedures.

General hygiene aspects of eco-sanitation

· Urine diversion is always recommended. This reduces the amount of faecal material to be sanitized and lowers the risk for disease transmission. This also reduces odours and flies.

· Faecal collection should occur above ground in closed compartments that will not leak into the groundwater or the surrounding environment.

· Handling and transport systems should involve minimal contact with the faeces.

· Toilet paper and material such as tampons and sanitary pads/napkins should only be put into the toilet if they are bio-degradable. Otherwise, they should be treated as solid waste.

· Anal cleansing water should not be mixed with urine, but infiltrated into soil or added to the greywater and subsequently treated.

· Contents of potties and diapers/nappies and should be put into the faecal compartment.

· Further addition of absorbent material, such as ash or lime, or a bulking agent, such as sawdust, may be needed when diarrhoea is prevalent.

References

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Winblad, U. and Simpson-Hébert, M. (eds) 2004. Ecological Sanitation. Stock-holm Environment Institute: Stock-holm, Sweden.

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(4)Safe handling

After urine and feces are collected into separate containers both must be removed and emptied into designated places.

□ Urine

Tools: Urine collection tank/jugs(20L), Wheelbarrow, rubber gloves, mask, dipper (Urine feeder dipper; made by each pupil), small shovel

① Urine is collected into Urine collection tanks/jugs. These tanks must be emptied as they are filled up to 80% of its capacity, before start flowing out of the containers.

② A pupil who used the latrine must check the tank as logging off with the WASH club member who receives a key from the pupil.

③ If WASH member decides it is necessary to empty out the jug, the pupil must do so by following the procedure descried bellow.

(1) First, go and gather all the necessary tools with the WASH club member.
(2) Second, the pupil must put rubber groves and a mask to protect him/herself.
(3) Third, carefully disconnect an urine drain tube from the tank.
(4) Fourth, close a lid of the tank/jug not to leak but not too tight so that it can be open later to apply to the school garden.
(5) Fifth, place the tank/jug under the sun, in a designated place

④ At the end of the day or gardening class these collected urine are applied to the roots of plants on a flower bed and farming lot on school yard.

Caution: Do NOT apply urine under following conditions:

☆ it is only 1 month or less to harvesting time
☆ it is not a growing season
☆ more than the total amount of urine exceeds 125ml/ plant for maize (Corn)

(1) A teacher or other designated parson in charge of gardening project leads the pupils to the location of school gardening
(2) Write a “gardening journal” on names of the teacher, group, activity, tools used, weather, plant growth, observation, and other remarks.
(3) Transport the collected urine tanks/jugs to the location of school gardening by a wheelbarrow

(4) Dig a hole next to the plant (maize). Off-load the jugs

(5) Measure the urine 125ml by a hand-made dipper

(6) Divert the dipper and pour the urine into the hole.

(7) Cover the hole with soil after urine was applied
(8) Left over urine can be added to holes next to trees, flowers, or pastures.
(9) In this case two litters of urine are added first, followed by ten litters of water (The technique works well on banana plants), twice a week.
(10) Wash your groves with soap and dry under the sun
(11) Remove the mask and
(12) Wash your hands with soap after storing the tool back into the storage unit
(13) Log off and record the day’s activity
(14) The teacher check the tools and logbooks/journal

(*Photos: Toilets That Make Compost. Low-cost, sanitary toilets that produce valuable compost for crops in an African context. (Peter Morgan Aquamor: Harare, Zimbabwe. Stockholm Environment Institute EcoSanRes Programme. 2007)*

□ Composted feces

Tools: Clean and wet cloth/rug, rubber groves, spade, hoe, shovel, wheelbarrow, large bag

① Check the amount of feces accumulated in a vault through the hole of latrine slab. 1/3 deep from the top-edge of vault..

② Report to WASH Club member if it reaches to “critical line”

③ WASH Club member report to a teacher and form a meeting with WASH Committee to make a plan (date, names of people, procedure) to remove compost
④ Close the latrines for 6-8 month to age feces to be composted
⑤ Gather WASH Club and WASH Committee members along with others who are chosen to remove compost materials on the day that they agreed. Ware a protective clothe for a potentially hazardous environment.
⑥ Place and check all the tools needs for the work on the ground
⑦ Dig a hole in designated area to keep collected compost that will be applied to school gardening lots after its maturity is confirmed. Keep the soil excavated out from the lot to mix with composted materials later.
⑧ Put groves and masks
⑨ Slowly open the access gate of the latrine and keep the gate stay open: CAUTION: Build up composted feces can be avalanched out.
⑩ Use a hoe, rake, or shovel to remove the composted feces and put it into a wheelbarrow
⑪ Bring the wheelbarrow full of composted material to the hole made at step⑦.
⑫ Repeat ⑩ and ⑪ until the vault is emptied and buried it with the soil.
⑬ Record all the activities, clean and dry the tools, and wash hands and faces at the end of work.

caution

d-2 *Action plan for one composting & growing cycle*

General scheduling of activities around the composting and latrines(can be altered)

Time	2009							2010											2011						
	6	7-9			10-12			1-3			4-6			7-9			10-12			1-3			4-6			7
Operation																										
Latrine#1(M)																										
Latrine#1(F)			In-use					Closed/ composting																		
Latrine#2(M)																										
Latrine#2(F)																										
Latrine#3(M)																										
Latrine#3(F)																										
Removal of compost																										
Ground preparation																										
Cleaning of vault & slab																										
Gardening																										
Maize, sorghum																										
Applying Urine																										
Compost																										
Cassava																										
Urine- fed																										
Compost-fed																										
Fruit trees, flowers																										
Harvesting																										
Maize, sorghum																										
Cassava																										

***Stop applying urine one month before harvest*

technical data sheets for ecosan components

ecosan program - Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

South Africa: Urine diversion dehydration toilets in e'Thekwini Municipality (Durban), 2005.

WHAT TO DO WHEN BOTH VAULTS ARE FULL.

A. Do I need any tools?

You will need :

- A Cloth (clean and damp)
- Gloves
- A spade
- A hoe
- A large plastic or a Hessian bag (or sack)

B. How do I prepare?

Dig a hole one spade wide by one spade long by half a spade deep.

Keep the soil because you are going to use it.

C. How do I clean out the vault?

Put the Hessian bag under the opening at the back of the first vault.

Open the back cover to the vault which is to be emptied.

Put on gloves to protect your hands.

Use your hoe or rake to remove the waste material out of the vault and onto the hessian bag.

Drag the bag to the hole and then use your spade to shovel the waste material into the hole.

Keep on repeating until the vault is empty.

Rake together any contents from the vault that has dropped on the ground around the toilet and place in the hole.

D. Do I need to do anything afterwards?

Use the soil you dug out earlier to fill the hole and make a mound on top of the filled hole.

Walk over the soil until it is flat and hard.

Plant grass or a tree on top of the hole.

Tidy up around the toilet structure.

Replace the back cover to the vault.

E. Now that the vault is empty what must I do?

You need to move the pedestal and place it over the vault which you have emptied.

Take the plastic floor cover off the first vault.

Put the plastic cover in a safe place.

Move the pedestal back over the first vault (this is described at the beginning of the pamphlet).

Put the cover over the full vault.

Clean up, wash tools and the toilet pedestal and then wash your hands with soap

Toll free number: 080-13-13-013

WHAT TO DO WITH A FULL UD TOILET VAULT.

1. What must I do when the first vault is full?

Pour water into the pipe and at the same time GENTLY push a piece of wire into the hole to try and move the blockage. If the pipe is too badly blocked, then you must call 080-13-13-013 and ask for help.

3. You are now ready to move the toilet pedestal. This is what you do.....

Put the toilet pedestal over the empty vault so that the toilet lid opens towards the wall.

Check that the pipe work of the toilet pedestal fits into the pipe work (that you have checked) in the floor.

Gently push downwards so that the toilet fits well over the empty vault.

Replace the vault floor cover over the full vault.

4. Check that the pipe work is properly connected – pour a cup of water into the urine pipe (the front part of the toilet) and ask someone to look at the back of the vault. You should not see any water coming out. If there is water outside, the pipe work may not be correctly joined. Then you need to join it properly.

Your toilet is now ready for use again until the second vault is full.

It is important to keep things clean. When you have finished, you need to wash :

- The toilet pedestal
- Around the toilet
- Your hands with soap.

Why must the toilet pedestal be moved?

You will need to move the pedestal and place it over the second vault.

The toilet pedestal must be moved so that the second vault can be used while the contents of the full vault are allowed to dry.

2. How do I move the toilet pedestal?

Stand in front of the toilet and hold the toilet pedestal on each side.

Gently move it and pull it out of the floor.

Remove the vault cover from the empty vault and put it in a safe place. Now you need to check the pipes.

How do I check the pipe work?

The pipes for the first and second vault are joined.

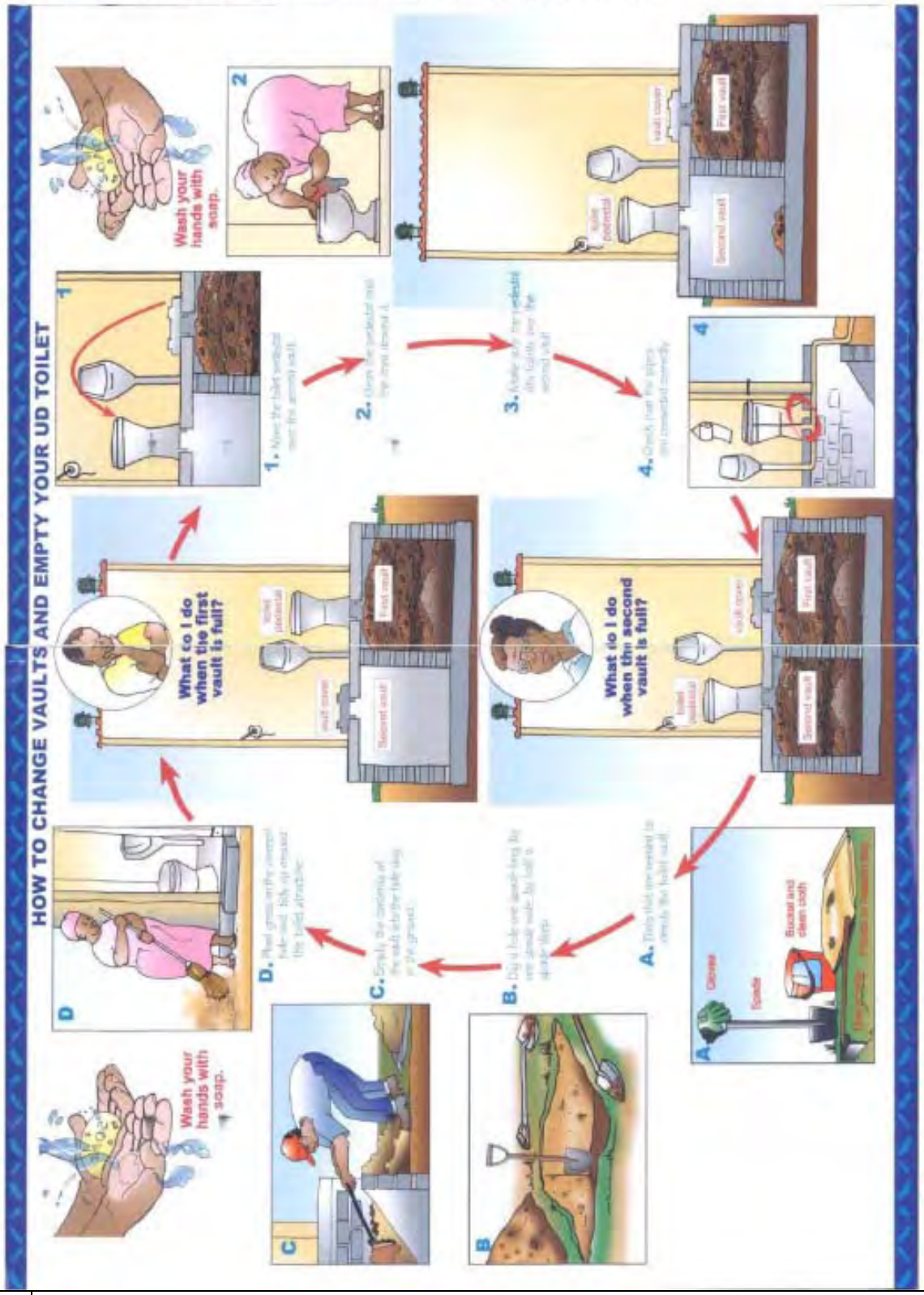
Pour a cup of water into the urine pipe to check that it is not blocked. If the water does not go down, the pipe needs to be unblocked

If the pipe is blocked, how can I unblock it?

technical data sheets for ecosan components

ecosan program - Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

South Africa: Urine diversion dehydration toilets in e'Thekwini Municipality (Durban), 2005.



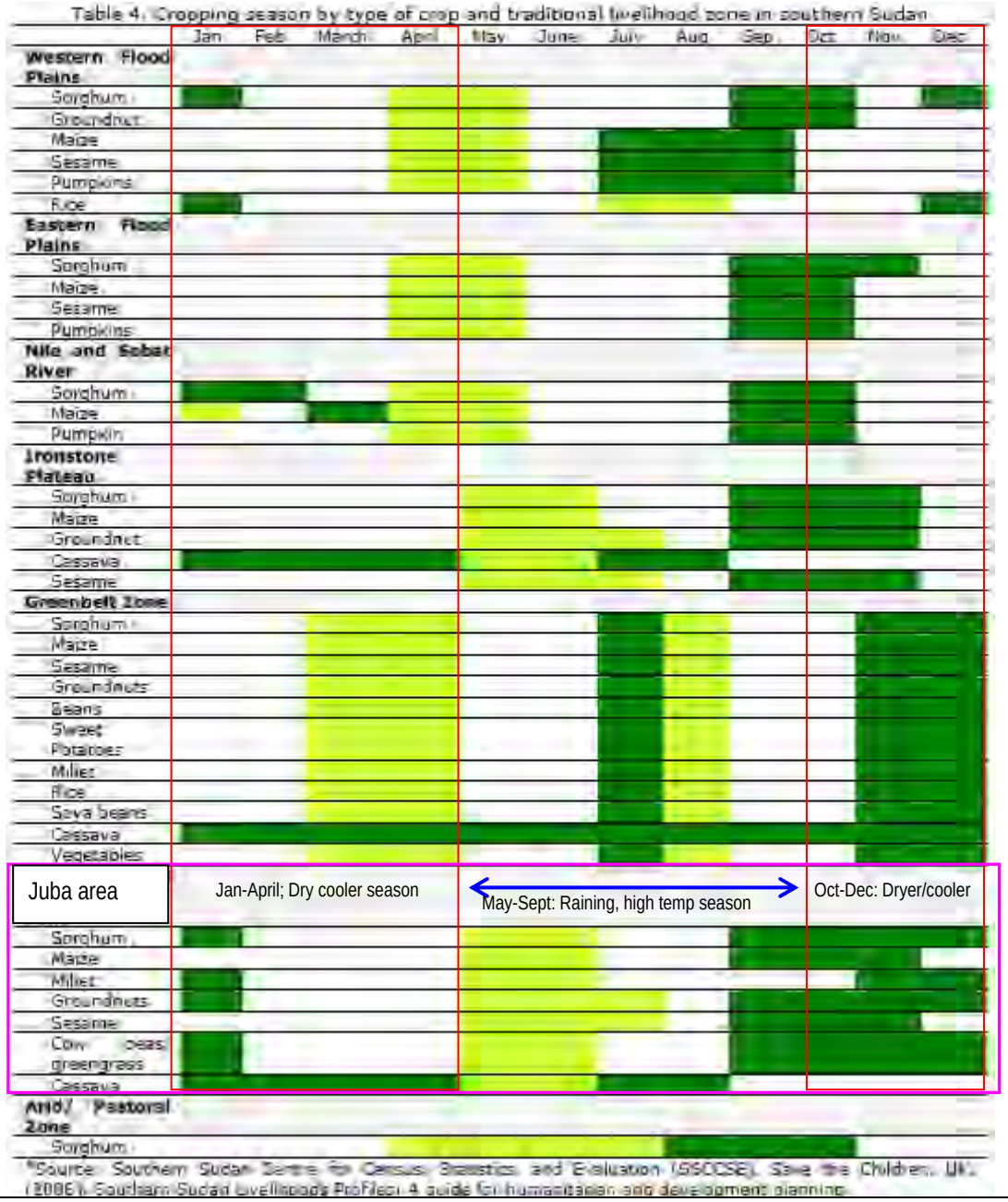
	(5) Gardening procedure
	□ *School gardening and agriculture; production and economy*
	Agricultural products suitable for Juba area (“Hills and Mountain” area)

Table 1. Traditional livelihood zones in southern Sudan

Livelihood Zone	Geography	Climate	Main livelihood
Green Belt	Western Equatoria and parts of Central Equatoria	Wet (1,350-1,600 mms of rain)	**Agriculture**- Sorghum, maize, cassava, millet, groundnuts, rice, sweet potatoes, fruit, sesame, tobacco, sugarcane, soya beans, vegetables, and coffee
Ironstone Plateau	West Bahr el Ghazal, Southern Warrap and Lakes	Wet (950-1300 mms)	**Agriculture**- Mainly sorghum and some Maize (assortment of other crops)
Hills and Mountains	Central Equatoria and parts of Eastern Equatoria and Jonglei	2 rainy season in the highlands; 1 rainy season in the lowland	**Agriculture**- sorghum, cassava, sweet potatos, millet, sorghum, cowpeas, groundnuts, and sesame **Pastoralism**- cattle, sheep, goats **Wild food**- roots, fruits, berries, leafy vegetables, and wild game
Arid/ Pastoral	Jonglei and Eastern Equatoria	Arid Sahelian savannah (less than 200 mms of rain)	**Pastoralists**- cattle, sheep and goats
Nile-Sobat Rivers	Jonglei, Unity and Upper Nile	Wet (700-1300 mms of rain)	**Agriculture**- sorghum, maize, groundnuts, okra, pumpkin, beans and other legumes **Livestock**- cattle, goats **Wild foods**- Water lilies, lalop, roots, vines, berries, leaves, bark, and tubers, and wild game **Fish**
Western Flood Plains	Northern Bahr el Ghazal, Warrap, and Lakes	Seasonal flooding	**Agriculture**- sorghum, groundnuts, maize, sesame, pumpkin, beans, millet and rice **Livestock**- cattle, goats **Wild foods**- shea butter nut, seeds of water lilly, tamarind, lalop, jackel berry, red fruit, wild rice, and zizupu mycronata **Fish**
Eastern Flood Plains	Upper Nile and Jonglei	Savannah grassland, and one rainy (700-1300 mms of rain)	**Agriculture**- sorghum, maize, cassava, sesame, pumpkin, beans, millet and root crops **Livestock**- cattle, goats **Wild foods**- lalop, water lilly seeds and reeds, tamarind, gum from acacia trees, fruits, roots, grains, leaves, and wild game **Fish**

Ref:Sudan: Southern Sudan-Comprehensive Food Security and Vulnerability Analysis (CFSVA), (2007). Jonathan Rivers et al., World Food Programme

Table 4. Cropping season by type of crop and traditional livelihood zone in southern Sudan



Source: Southern Sudan Centre for Census, Statistics and Evaluation (SSCCSE), Save the Children, UK. (2006). Southern Sudan Livelihoods Profiles: A guide for humanitarian and development planning.

□ *Composting and science, math, culture, music, play etc*

1. How to Use Urine and composed feces in the Garden

- A general rule of thumb is to apply the urine produced by one person during one day (24 hours) to one square metre of land per growing season (crop). The urine from one person will thus be enough to fertilize 300-400 m2 of crop per year and even up to 600 m2, if dosed to replace the phosphorus removed by the crop.
- For most crops, the maximum application rate before risking toxic effects is at least four times the dose above.
- The urine is applied prior to sowing and up until two-thirds of the period between sowing and harvest.
- Sanitized faeces should be applied prior to planting or sowing as the high phosphorus content is beneficial for root formation of young plants.
- The faecal matter should be within reach of the plant roots but it should not be the only growing medium.

Reference:

Toilets That Make Compost. Low-cost, sanitary toilets that produce valuable compost for crops in an African context. (Peter Morgan Aquamor: Harare, Zimbabwe. Stockholm Environment Institute EcoSanRes Programme. 2007)

Urine is a valuable supply of nitrogen and also phosphorus and potassium in smaller quantities. It is particularly useful when used to enhance the growth of green vegetables, onions and maize. It can also considerably enhance

the growth of fruit trees like banana and mulberry. Urine can be collected in bottles or from urine-diverting toilets. The following examples show what can be achieved by the use of urine application.

11.1 Crop trials using urine as a fertiliser

11.1.1 Rape

In Figure 11-1, the upper three basins of rape were fed 0.5 litres of a 3:1 water and urine mix, twice a week while the lower three basins received only water. The effect became noticeable after 10 days treatment and after 28 days of water and urine application the effect was very noticeable. Overall, rape yield was increased about 5 times by urine treatment (Figure11-2)

Figure 11-1: Rape crop trials

Figure 11-2: Rape crop yields

11.1.2 Spinach

In Figure 11-3, the two columns of basins of spinach on the left were fed 0.5 litres of a 3:1 water and urine mix twice a week while the two columns of basins on the right were fed only water. The effective of the urine treatment is very positive and very clear to see. Overall, the spinach plants fed with diluted urine weighed 3.4 times more than spinach fed with only water (Figure 11-4).

Figure 11-3: Spinach crop trials

Figure 11-4: Spinach crop yields

11.1.3 Mint and passion fruit

Mint and passion fruit also respond very well to water and urine treatment (Figure 11-5 and Figure 11-6). A weekly application of a 5:1 mix produces a significant increase in growth. This can be stepped up to two applications a week. Normally 0.5 litres of the mix per container is sufficient.

Figure 11-5: Mint after urine treatment

Figure 11-6: Passion fruit after urine treatment

11.1.4 Onion

Some very good looking onions can be grown in cement basins with the help of a water and urine feed. Onion

seeds are best planted early in the year, late January or February being good times, so they can be transplanted into containers towards the end of the rains in April. This healthy onion (Figure 11-7) was harvested in early September after six months of water and urine treatment in a 10 litre cement basin. An amount of 0.5 litres of a 5:1 mix of water to urine was applied once a week during the six-month period together with intermediate watering. Such a result reveals the usefulness of urine as a plant food.

Figure 11-7: A prize specimen of onion

11.1.5 Maize

Urine can have a significant effect on maize growth. In the fields urine can be applied straight to soil before planting in beds. It can also be applied straight in hollows made near the growing plant. Maize is rarely if ever grown in containers, but the effect of the growth of maize in containers when fed urine is stunning and well suited for demonstration. Maize plants are hungry feeders and like a lot of nitrogen. The application of a 3:1 mix of water and urine, once or twice or even three times a week on maize grown in 10 litre containers is particularly effective. Figure 11-8 shows the striking difference between a maize plant fed with a 3:1 mix of water and urine (0.5 litres) three times per week and maize irrigated with water only. Urine treatment also improves maize cob yield significantly. The total yield of cobs from maize planted in three 10 litre basins was dramatically different depending on how much diluted urine was used on the crop (Figure 11-9). Maize fed with 1750ml of urine per plant over the 3.5 month growing period resulted in a crop of 954 grams, compared with 406 grams for maize fed with 750ml of urine per plant, and only 63 grams for the maize irrigated with water only. These rates of urine application are quite high, but are happily accepted by the maize plants in the containers, which were irrigated frequently with water to keep the maize plants healthy. For small scale maize or sweet corn production, this method may have an application. It is also a useful way of demonstrating the effect of converting the nutrients held in urine into vegetative growth of valuable plants.

Figure 11-8: Maize fed with water only (left-side) and diluted urine (right-side)

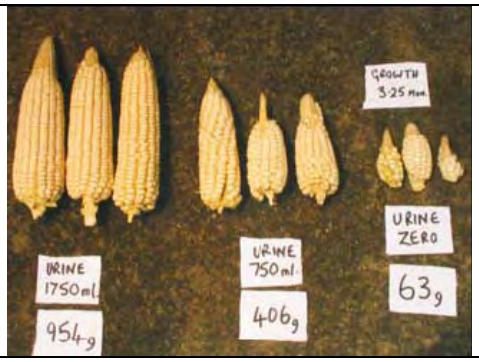


Figure 11-9: Maize cob yields

11.2 Effect of urine use on maize growth on poor sandy soils: A field trial in Epworth near Harare Epworth is a large peri-urban settlement of about 200,000 people close to Harare. It was chosen as an experimental site to demonstrate the effectiveness of urine as an alternative to commercial fertiliser for maize production because it is characteristic of the conditions under which millions of people live both in peri-urban and rural areas in Southern Africa. Natural Epworth topsoil is sandy, porous, almost without nutrients and applied nutrients can easily be lost by leaching during heavy storms. Without commercial fertiliser or manure, maize and vegetable crops are generally very poor on soils of this type. In the experiment, the field was dug and levelled beforehand and on planting day hundreds of small holes 30cm apart in rows 90cm apart were dug. A 20 litre drum of collected urine is shaken up and applied in 125ml amounts (Figure 11-10) to each hole. This was followed by a 500 gram plug of toilet compost. Two seeds of maize were planted in the compost and covered over with topsoil (Figure 11-11). If seeds are in short

supply then a single seed can be planted. Over 90% of registered maize seed will germinate. After germination 125ml of urine was applied at weekly intervals to each young maize plant (Figure 11-12). A crop of untreated maize shows the distinct difference in growth compared to the urine-treated maize (Figure 11-13).

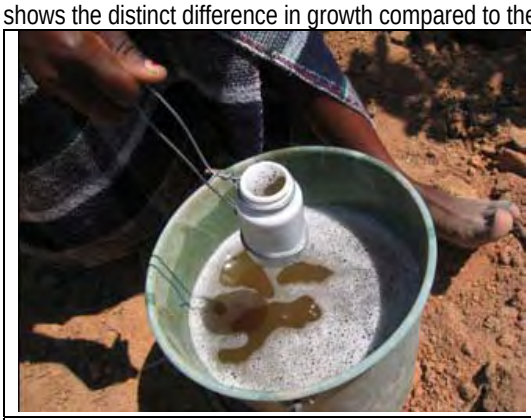


Figure 11-10: Measuring urine

Figure 11-11: Maize seeds planted on 11 November 2004

Figure 11-12: Application of urine to a young maize plant

Figure 11-13: Comparison between urine-treated (right-side) and untreated (left-side) maize crops

Before applying urine to a maize plant, a small hole should be dug near to the plant (Figure 11-14). After applying the 125ml of urine in the small hole next to the plant (Figure 11-15), it is best to cover over with soil after application to slow down nitrogen loss. The total amount of urine added to each plant was 1000ml – eight doses of 125ml. After the initial dose, a dose was given weekly for five weeks followed by a dose every other week for the final two doses. The 1000ml of urine is equivalent to around 5 grams nitrogen, about the same as the dose used with commercial fertilisers.

Figure 11-14: Digging a hole for urine application

Figure 11-15: Applying the urine

Figure 11-16: First sign of tassel from 17 January 2005

Figure 11-17: First sign of the cob from 17 January 2005

After just over two months of growth, the first signs of the maize tassel and cob appear (Figure 11-16 and Figure 11-17). After two-and-a-half months, the growth of maize has been good and cobs are already forming. By comparison, maize planted at the same time but not treated with urine shows smaller and paler plants with little cob formation (Figure 11-18). Overall, the application of 1 litre of urine per plant doubled the grain yield of maize growing on poor sandy soil compared to unfed plants.

Figure 11-18(Left) : Maize crop on 31 January 2005 – comparison of urine-treated maize (right-side) with untreated maize (left-side)

11.3 Effect of urine treatment on trees

Once established many trees can gain great benefit from the regular addition of the nitrogen and other nutrients in urine. Trees like banana, mulberry, mango and avocado are good examples. The addition of wood ash also helps to provide extra potassium which fruit trees need. The trees can also be fed with compost, manure or other fertilisers as they grow and require extra feeding. Urine can be applied to trees directly from a urine-diverting toilet (Figure 11-19) or slowly through a hole in a bucket (Figure 11-20). Alternatively a hole can be dug next to the tree for water and urine application (Figure 11-21). In this case two litres of urine is added first (Figure 11-22), followed by ten litres of water. The technique works well on banana plants. In Figure 11-23, the plant shown grew rapidly after the start of the rains and with the application of 2 litres of urine mixed with 10 litres water, twice per week. The bucket was fitted with a small pipe near the base to allow the water and urine mix to escape slowly into the ground (Figure 11-23 and Figure 11-24). This can also be achieved by drilling a small hole in the base of the bucket. Phosphate sediment will be leftover in the bucket and this is poured on the soil after the bucket is empty.

Figure 11-19: Urine applied to a banana tree directly from

Figure 11-20: Urine applied to a banana tree through a

the toilet	bucket
	
Figure 11-21: Preparation for urine application in a hole near the tree	Figure 11-22: Application of the urine into the hole
	
Figure 11-23: Bucket fitted with small pipe to apply urine	Figure 11-24: Inside view of bucket with pipe to apply urine

Figure 3. Urban agriculture in Kampala, Uganda, supplies the city with a substantial percentage of the food intake. Photo: Margaret Azuba.

Ref. *EcoSanRes: Urine Diversion:One Step Towards Sustainable Sanitation*. 2006. Elisabeth Kvarnström et al.

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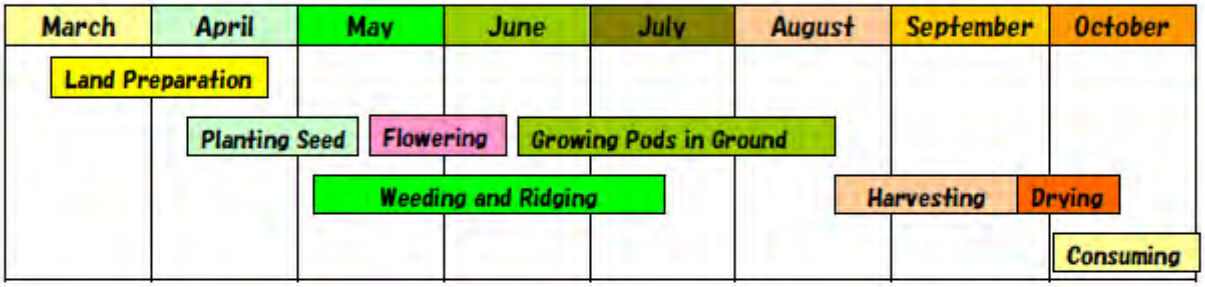
Cultivation Manual No.1 Groundnut (Peanut)

Characteristics of Groundnut

Groundnut is an annual herbaceous plant growing from 30 to 50cm tall, with four leaves. The flowers are a typical pea flower in shape, 2 to 4cm across, yellow with reddish veining. After pollination, the fruits develop into a legume (pea) of 3 to 7cm long, containing 1 to 4 seeds, which forces its way underground to mature. Peanuts grow best in light, sandy loam soil. They require five months of warm weather, and an annual rainfall of 500 to 1000mm.

Cultivation Calendar



Soil:

Sandy soil with generous amounts of compost and manure is preferable. Prepare the soil by digging several inches deep. Avoid using the same land/soil where groundnut was planted in previous season.

Seeds:

It is advised that you select seeds which are kept with shells in cool and dry place after harvest, not infected by disease or insects while storing. If you use your own seeds, remove shells right before sowing. Recommended seed rate is 25kg (without shell), or 60kg (with shell) per Fedan.

Planting:

Depth: 3 to 10cm

Spacing:15 to 20cm between plant and 30 to 50 cm between rows.

Blind (empty) pods are the result of too much rain or humidity at flowering time. If your soil does not drain well, slightly elevate or mound the rows. The peanut pods, or pegs will grow from a large stem which bends down and pushes into the soil. If the soil is too hard, add a couple of inches of mulch and

sand on top of the soil.

Weeding

Weeding is necessary especially after 2 to 3 weeks of germination. After weeding, add some soils near the roots of plant. Weeds take away nutrients and prevent the plants from growing. Further, weeds make the digging and threshing operations very difficult, resulting in high losses.

Crop Protection:

Crop develops weeds, pests and diseases which can affect the yield and quality of the final crop. Managing the crop well through the various development stages need experiences and attentions. You also need to take necessary measures to protect your plants form insects, birds and animals throughout the growing period.

Harvest:

Harvesting at the right timing is crucial. Pods ripe in 120 to 150 days after sowing. If the crop is harvested too early, pods remain unripe. If harvested late, pods will snap off at the stalk, and will remain in soil. Foliage of the plant will be yellow when it is ready for harvesting. When you harvest, lift the "bush" from the ground and shakes it, then invert the bush, leaving the plant upside down on the ground for 3 to 4 days to keep the peanuts out of dirt and make them dry slowly, up to one third of their original moisture level.

Drying:

Allow peanuts be dried sufficiently and remove the pods from the bush.

Post Harvest

Storage:

Allow the peanuts to dry for 2 to 4 weeks. Store in a cool place until you are ready to consume or sell. Poor storage of peanuts can lead to an infection by the mould.

Utilization

Peanuts seed is delicate and needs care and attention from planting to harvesting, curing, shelling, storage and seed preparation. Remaining of plants (i.e., hay, grass, leaves) can be utilized as a good quality, palatable stock feeds during the dry season if you store it properly after harvest. Peanuts have a rich source of protein (roughly 30 grams per cup after roasting). It is advised that when you take peanuts as a staple, you should also take it with other complementary grains such as corn and wheat, which are adequate in methionine but limited by lysine. Protein combining has been largely discredited.

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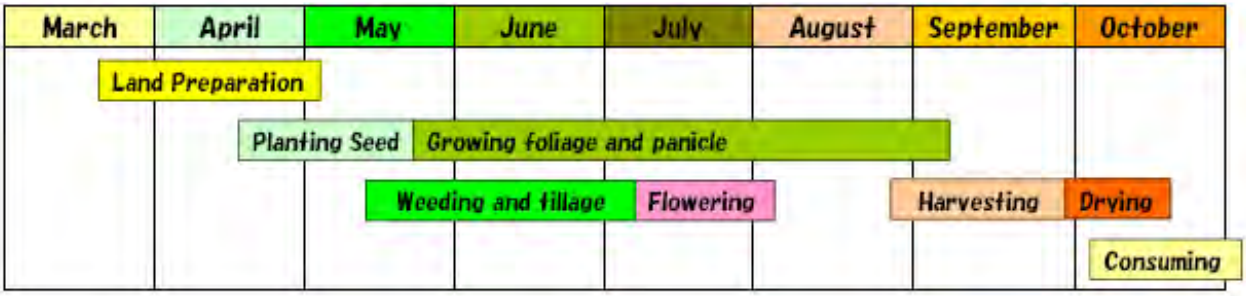
Cultivation Manual No.2 Sorghum

Characteristics of Sorghum

Worldwide, sorghum is a food grain for humans. Growth and development of sorghum is similar to maize, and other cereals. The grain has more protein and fat in comparison to corn, but is lower in vitamin A. When compared with maize on a per pound basis, grain sorghum feeding value ranges from 90% to nearly equal to maize.

Cultivation Calendar



Soil:

Sorghums can tolerate a wide range of soil pH and textures, that is it can tolerate with wet soils and flooding as well as droughts.

Seeds:

It is recommended to use good seeds which kept in cool and dry place from previous harvest, and not infected by any disease or insects while storage. Recommended seed rate is 3kg per Feddan. Grain yields decrease with the delay of planting, especially when planted after early June.

Planting:

Depth: 3 to 6cm

Spacing: 5 to 10cm between plant and 40 to 80 cm between rows.

Sowing: 3 to 5 grain of seed in a hole or spot of sowing

It is important to place the seed in moist soil to obtain fast germination. Spacing can be reduced with rich soil fertility, moisture, and sunlight. In some areas, reduced- and no-tillage (harrow) systems are applied for grain sorghum.

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Weeding

Weeding is one of the most important parts of cultivation. It is necessary to weed after 2 to 3 weeks of germination. Remember, weeds take away nutrients and prevent the plants from growing.

Crop Protection:

Crop develops weeds, pests and diseases which can affect the yield and the quality of grain. Pay attention to your crop and its surroundings throughout all the growing period. You also need to take necessary measures to protect plants form insects, birds and animals especially right before harvest.

Harvest:

Timing of harvest will depend on weather. When the grain is dried enough, cut panicles from the top of the plant and take them out of the farm field to dry them by spreading on a sheet under the sunlight. Thresh the panicle when the seed moisture is less than 25 percent. Then, remove chaffs by wind separation from grain.

Drying:

Dry sufficiently after threshed grain for about 3 days by the sunlight for packing and storage.

Post Harvest

Storage:

Store in a cool and dry place until you are ready to consume or sell. Grain should be stored at about 13% moisture in clean bins.

Utilization

In communities where sorghum is grown as a subsistence crop, main food products which can be prepared at home include thin and thick porridges, fermented and unfermented breads, lactic and alcoholic beers and beverages, malted flours for brewing, malted porridge mixes and weaning foods.

There is a small but growing market for pearled (white) sorghum as an alternative to rice. You can find in the markets the composite wheat-sorghum flours, maize-sorghum flours these days to promote more consumption of sorghum with other grains.

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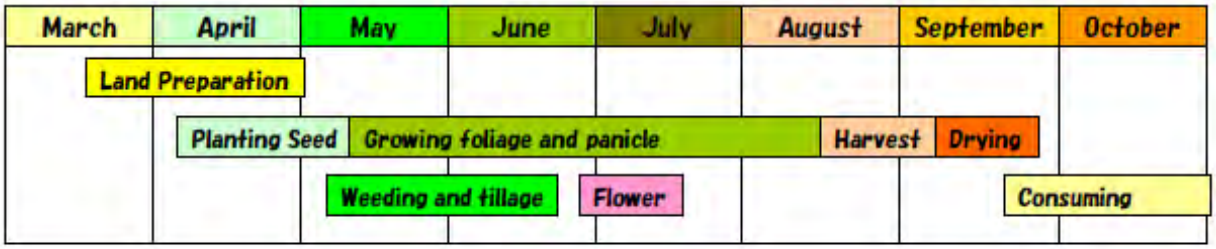
Cultivation Manual No. 3 Maize

Characteristics of Maize

Maize is cultivated widely in the world and it's production is marked the highest of all other grains every year.
Maize serves as basic raw material for the production of starch, oil and protein, alcoholic beverages, food sweeteners and more recently fuel.

Cultivation Calendar







Soil:
Maize prefers fertile soil with generous amounts of compost and manure. Prepare the soil by digging several inches deep. Avoid using the same land/soil where maize was planted in previous season.

Seeds:
It is recommended to use good seeds which kept in cool and dry place from previous harvest, and not infected by any disease or insects while storage. Recommended seed rate is 6kg per Feddan.

Planting:
Depth: 10 to 12cm
Spacing: 10 to 20cm between plant and 40 to 80 cm between rows.
Sowing: 2 to 3 grain of seed in a hole or spot of sowing

Due to its shallow roots of only 3 to 6 cm deep, maize is susceptible to droughts, intolerant of nutrient-deficient soils, and prone to be uprooted by severe winds. Maize is most sensitive to drought at the time of silk emergence, when the flowers are ready for pollination.

Weeding
Weeding is one of the most important parts of cultivation. It is necessary to weed after 2 to 3 weeks of germination. Remember, weeds take away nutrients and prevent the plants from growing.

Crop Protection:
Crop develops weeds, pests and diseases which can affect the yield and the quality of grain. Pay attention to your crop and its surroundings throughout all the growing period. You also need to take

necessary measures to protect plants form insects, birds and animals especially right before harvest. Maize is often planted with a nitrogen-fixing crop, such as soybeans in longer summer area to get better yield.

Harvest:

Timing of harvest will depend on weather. When the crop is dried enough, take out of ears from the plant and take them out of the farm field to dry them by spreading on a sheet under the sunlight after removing perucarp (skin). Then remove kernels from corncob when it is dried enough. Then, separate chaffs by wind from grain.

Drying:

Dry sufficiently after threshed kernel for about 3 days by the sunlight for packing and storage.

Post Harvest

Storage:

Store in a cool and dry place until you are ready to consume or sell. Grains should be stored at less than 13% moisture in clean bins.

Utilization

Maize and maize flour constitutes a staple food in many parts of the world. Maize can be cooked into a thick porridge in many countries including *polenta* of Italy, *angu* of Brazil or sadza, nshima, ugali, and mealie pap in Africa. Maize is also used as a replacement of wheat flour, to make cornbread and other baked products. Chicha and "chicha morada" (purple chicha) are drinks made usually from particular types of maize. The first one is fermented and alcoholic, the second is a soft drink commonly drunk in Peru.

Maize can also be harvested and consumed in the unripe state, when the kernels are fully grown but still soft. Unripe maize must usually be cooked to become palatable; this may be done by simply boiling or roasting the whole ears and eating the kernels right off the cob. The cooked unripe kernels may also be shaved off the cob and served as a vegetable in side dishes, salads, garnishes, etc.

Maize is a major source of starch, a major ingredient in home cooking and in many industrialized food products. It is also a major source of cooking oil and of maize gluten. Grain alcohol from maize is traditionally the source of bourbon whiskey.

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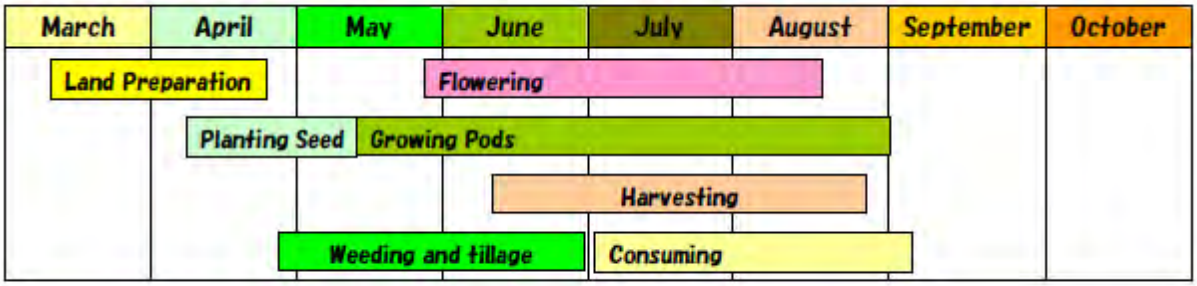
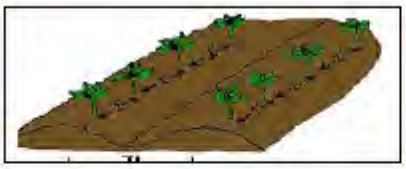
Cultivation Manual No.4 Okra

Characteristics of Okra

Okra is grown all over the world and it is in the same plant family as hibiscus and cotton. Okra is among the most heat- and drought-tolerant vegetable species in the world. It will tolerate poor soils with heavy clay and intermittent moisture.

Cultivation Calendar





Soil:

Well drained sandy loams high in organic matter are the most desirable. Since okra is susceptible to several soil borne disease pests, it is advisable to avoid using the same land/soil where okra was planted in the previous season.

Seeds:

It is advised that you select seeds stored in cool and dry place after harvest, not infected by disease or insects while storing. Seed rate is about 5kg per feddan.

Planting:

Depth: 3 to 4cm (seeds should be soaked overnight prior to planting).

Spacing: 20 to 40cm between plant and 80 to 100 cm between rows.

Cutting back okra will allow the plant to rejuvenate and produce crop agein.

Weeding

Okra is harvested over a long period of time and the weed control should be done throughout the whole growing period. It should be tilled shallow and necessary to weed very frequently.

Crop Protection:

The insects found on okra vary from year to year, but generally various beetles (flea, Japanese, blister and cucumber beetles) and worms (mostly corn earworm) are most common. If you find eggs or larvae of pests on leaves and stem of the plant, take them away from the leaves and from the farm. The more serious disease pests are root knot nematode, Southern stem blight and wilt. A combination of crop rotation and soil fumigation is important for controlling these diseases.

Harvest:

Generally pods are harvested when 6 to 10cm long. The plant continues producing new pods so long as the matured ones are harvested. Matured pods left on the plant will reduce flowering and fruit set. To achieve maximum yields, the pods must be harvested every other day. Most pods are ready for harvesting 4 to 6 days after blooming. Pods may be cut with a knife or snapped off by hand.

Storage:

Harvested okra will be deteriorated rapidly, normally stored only for a short period. If the pods are in good condition, they can be stored 7 to 10 days at 6 to 10℃ and 90 to 95% humidity. Upon removal from storage, the pods must be sold relatively quickly. At temperatures below 6℃, okra is subject to chilling injury which results in surface discoloration, pitting and decay.

Utilization

Okra can be served raw, marinated in salads or cooked on its own, and goes well with tomatoes, onions, corn, peppers, and eggplant. Whole, fresh okra pods also make excellent pickles.

The products of plant become sticky when the seed pods are cooked. In order to avoid this effect, okra pods are often stir fried to take away moisture, or paired with slightly acidic ingredients, such as citrus or tomatoes. The cooked leaves are also a powerful soup thickener. Okra leaves may be cooked in a similar manner as the greens of beets or dandelions. The leaves are also eaten raw in salads. Okra seeds may be roasted and ground to form a non-caffeinated substitute for coffee.

Okra oil is a pressed seed oil, extracted from its seeds. The greenish yellow edible oil has a pleasant taste and smell, and is high in unsaturated fats such as oleic acid and linoleic acid.

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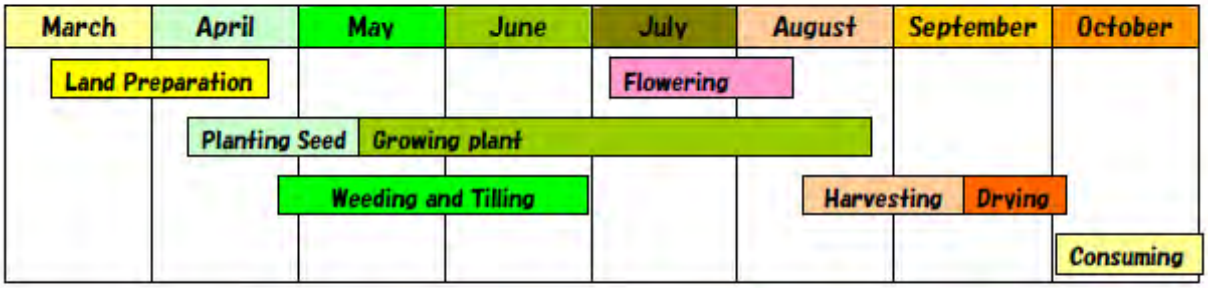
Cultivation Manual No.5 Sesame(Simsim)

Characteristics of Sesame

Sesame is an ancient oilseed, first recorded as a crop in Babylon and Assyria over 4,000 years ago. Women of ancient Babylon used to take a mixture of honey and sesame seeds to prolong youth and beauty and the Roman soldiers for strength and energy.

Cultivation Calendar






Soil:

A wide range of soils are applied for sesame cultivation. However, well-drained, loose, fertile and sandy alluvial soils are preferred that have a pH value between 5.4 and 6.75. Sesame is resistant to drought and tolerant to insect pests and diseases. Sesame is a low cost crop for production and therefore one of the best rotation crop of cotton, maize, groundnut, and sorghum.

Seeds:

Seeds should not touch the ground during harvesting in order to avoid an infestation of soil borne diseases. The seed shells must remain intact to protect the seeds from infection, and to maintain their ability to germinate. Recommended seed rate is 1.5kg per Feddan.

Planting:

Depth: 1.5 to 2.5cm

Spacing:15 to 20cm between plant and 45 cm between rows.

Mixing seed with sand, dry soil, ash or dried, sieved manure or compost will help to make seed distribution more uniform. In order to achieve an optimum crop density, branching varieties should be singled out to 6-10 cm, or at maximum less than 15 cm distance within the rows when they reach the height of 5-10 cm. Sesame is often sown with other crops such as pigeon peas, maize or sorghum.

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Weeding

Young sesame plants grow very slowly during the first 25 days, due to the small seed size, and are not yet strong enough to compete against weeds. Natural weed resistance sets in when growth rapidly accelerates, after the plants have attained a height of 10 cm. For this reason, the field should be kept as weed-free as possible during the first 20-25 days after seeding. This is usually achieved through 2-3 hand cultivations or by slashing weeds at soil surface as soon as practically possible, and hand weeding the rows of crops.

Crop Protection:

Sesame is often sown as an opening crop in a rotation, as it requires a fertile soil. In this case grasses must be eradicated as sesame is a poor competitor to weeds. Planting must be done as early in the rains as possible. Weeds take away nutrients and prevent the plants from growing. Further, weeds make the digging and threshing operations very difficult, resulting in high losses. Sesame is an excellent rotation crop of cotton, maize, groundnut, wheat, and sorghum. It reduces nematode populations that attack cotton and groundnut.

Harvest:

Sesame matures between 3-4 months. If harvesting is delayed, most of the yield will be lost. The plants are cut to a height of 10-15 cm, or uprooted before the capsules are fully ripened. The optimum time for harvesting is when the first, lowest capsules turn brown and begin to pop open, and the stem turns yellow. Sesame is harvested by hand, and then left to dry for the first 2-3 days after cutting in a windrow. The leaves dry out quickly there, making it easier to bundle them into sheaves. The sheaves should be positioned so that the sun can shine down directly onto the capsules. When the sheaves have dried out fully, they are tipped out onto sturdy cloths or canvases and threshed with sticks.

Drying:

Dry out to a moisture content of 6% as rapidly as possible on a clean plastic sheet to avoid contamination.

Utilization

Sesame seeds are either consumed directly as a highly nutritious foodstuff or processed by the confectionery and bakery industries. Sesame hay, if carefully dried, can be used as fodder. A large proportion of the world's sesame production goes towards producing edible oil. Purely white sesame seeds are in demand on conventional as on ecological markets, because of their higher oil content than pigmented varieties.