Japan International Cooperation Agency

Agriculture and Food Authority
Horticultural Crops Directorate

Ministry of Agriculture, Livestock and Fisheries
State Department for Crop Development & Agricultural Research

Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS)

"Changing Farmers' Mindset from "Grow and Sell" to "Grow to Sell""

CHILI PRODUCTION

Presented to the County & AFA (HCD) Staff in charge of the SHEP PLUS Model Farmer Groups during the FT-FaDDE

Prepared by SHEP PLUS

1. Introduction:

1.1 Background

- Chili is a member of the ***Solanaceae* family** which includes crops such as **Potato**, **Tomato**, **Black Nightshade** and **Egg Plant** among others
- Chili is a plant of **tropical** and **subtropical regions** grown for their fleshy fruits
- Fruits are consumed **fresh**, **dried** or in **processed form** as a table vegetable or spice
- Chili produces pungent chemical called **capsaicin**
- **Scoville scale** is used to measure pungency with sweet peppers being mild & Cayenne scorching
- Fruits are a rich source of **Vitamin A** & **C, B_6.** Also high in **K, Mg,** and **Fe** (AVRDC).

1.2 Common Varieties

Photo: © Maja Dumat
https://www.flickr.com/photos/blumenbiene/6133232355

Photo: SHEP PLUS

“Long Cayenne”

“African Bird’s Eye Chili”

1.2 Common Varieties

“Long Cayenne”:

- Plant is **tall** and **highly productive**
- Fruits are **long and slim** (**10cm**)
- The flesh is **very thin** and **very pungent**
- A popular export variety
- Also suitable for local fresh market and drying

“African Bird’s Eye (ABE) Chili”:

- Plants are perennials that grow as shrubs (bushy)
- Fruits are **small, clustered**, **erect**, **conical** and **pointed** (**up to 3cm long**)
- Immature pod color is **green**, mature color is **bright red or purple**
- Fruits are **extremely pungent (hot)**

1.3 Other Varieties

- Anaheim
- Fresno
- Jalapeno
- Rocket
- Short Bullet

1.3 Optimal Ecological Requirements

Altitude	**0 – 1,200 metres above sea level**
Rainfall	**600 – 1,200 mm of rainfall annually**
Growing Temperature	**20 – 30 ^{0}C**
Soils	**•Various soil types that are well drained** **•pH range 6.0 – 6.5**

2. G20 technologies

- **Make sure to support farmers carry out G20 techniques for any crop**

1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/ manure
9. Recommended practices of seedling preparation/ seedlings from registered nursery

2. G20 technologies

10. Recommended spacing
11. Recommended fertilizer application rate
12. Supplementing water
13. Timely weeding
14. Top-dressing
15. IPM practices
16. Safe and effective use of pesticides
17. Use of harvesting indices
18. Appropriate post harvest handling containers
19. Value addition techniques
20. Keeping farm records

3.1 Raising Seedlings

Photo: SHEP PLUS

A transplanted chili seedling

3.1 Raising Seedlings (GHCP&PHHT20: Q9)

- Chili can be established through the nursery
- The seed rate is about 75 **g/acre**

Nursery Site Selection:

- The nursery should be sited in a plot that has not been planted with a member of ***Solanaceae*** **family** for the last **3 years**
- Choose a site with **rich**, **well drained, friable soil**
- Choose an area near **a water source** and **protected from animals**

3.1 Raising Seedlings Cont’

Nursery Establishment:

- **Nursery bed: 1 m** width by any desired length
- Till until soil is fine
- Mix soil with **10 – 15 kg** of potent manure **per square meter**
- Sow the seeds **1.5 cm deep** in holes at a spacing of **15 – 20 cm apart**
- Cover the bed with **mulch** and **water** thoroughly

3.1 Raising Seedlings Cont'

Nursery Establishment Cont':

- Use of seedling trays is recommended, especially for **expensive hybrid seeds**
- Seedling trays offer **more uniform germination** and **growth**

Management of Nursery:

- Water **once a day**
- Where possible, **check soil moisture** before watering

3.1 Raising Seedlings Cont'

Management of Nursery Cont':

- As soon as seeds start germinating, **remove mulch** and create **a temporary shade above the seedbed (about 50 %)**, using **shade net** or **grass mulch**
- Monitor for **disease and pests** regularly and **react accordingly**
- Germination is complete **after 1 to 3 weeks**
- Seedlings should be **hardened off in the 4th and 5th week** after emergence by reducing shade and watering frequency to **3 times** per week

3.2 Transplanting

3.2.1 Appropriate Time:

- Seedlings are ready for transplanting **5 – 6 weeks after emergence** (**4 – 6 leaf stage**)
- Transplanting done at the beginning of the rainy season to give seedlings a good start
- Water nursery beds before lifting the seedlings with a ball of soil around their roots
- Plant seedlings when temperatures are low

3.2.2 Recommended Spacing

(GHCP&PHHT20: Q10):

- **Spacing: 60 X 40 cm** or **70 X 30 cm** are recommended depending on variety
- Plant population: **16,666-19,000**

3.5 Transplanting Cont'

3.2.3 Fertilizer Application Rates (GHCP&PHHT20: Q11):

- A basic dressing of **100 kg per acre** of **TSP** or **DAP** depending on soil analysis results
- Well decomposed manure should be incorporated at a rate of **10 tones per acre**
- Both fertilizer and manure should **be well incorporated** in the soil before transplanting

3.4 Water Requirement (GHCP&PHHT20: Q12)

- Plants should be provided with **adequate water** which is well distributed. Crop irrigation should be considered in areas experiencing rainfall below 600mm/year
- During fruit development, water stress will lead to **fruit** and **flower abortion**

3.5 Top-dressing (GHCP&PHHT20: Q14)

- **Top-dressing** can be done first when plants are **about 15 cm**, then **4 weeks later** for the second time
- **1st top-dressing:**
  - **In acidic Soils: 40 kg** per acre of **CAN**
  - **In alkaline Soils:** 50 kg per acre of SA (Sulphate of Ammonia)
- Foliar feeds high in magnesium are desirable on alkaline soils
- **2nd top-dressing: 80 kg per acre** of **CAN** or **SA**

Note: Type of fertilizer and application rate will depend on results of soil analysis

3.6 Pests & Diseases Control:
(GHCP&PHHT20: Q15 & 16)
3.6.1 Major Pests

A. False Coddling Moth
B. Aphid
C. Cutworm
D. Thrips
E. Red Spider Mite
F. Root-knot Nematode

3.6.1.A: False Codling Moth

Photos: Marja van der Straten, NVWA Plant Protection Service, Bugwood.org (CC BY-NC 3.0 US)

Adult and larva of false codling moth

3.6.1.A: False Codling Moth

Identification:

- The adult is nocturnal and attracted to light
- When full grown, the larva descends to the ground on a silken thread and spins a tough silken cocoon in the soil or amongst debris.

Symptoms:

- On fruits, the young larvae mines just beneath the surface, or bores into the pith causing premature ripening of the fruits

3.6.1.A: False Codling Moth

Control:

- **Use of Pheromone Trap**
- **Sanitation, crop rotation** with non-host crops such as beans, carrots
- Destruction of **wild** and **cultivated hosts**
- Control of **weeds**

Note: use of trap crops e.g. sorghum has shown promise as a trap crop against the pest in cotton

Photo: SHEP PLUS

3.6.1.B: Aphid

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org (CC BY 3.0 US)

Aphids on a leaf

3.6.1.B: Aphid

Identification:

- Aphids are **soft-bodied insects** that cluster in shaded areas on the **leaves**, **stems** and **blossoms**
- Winged aphids move from field to field **spreading viral diseases**

Symptoms:

- **Sticky honey dew**
- Feeding injury in the form of **curling leaf margins**, **yellow spots** & **leaf distortion**

3.6.1.B: Aphid Cont’

Symptoms Cont’:

- **Leaf drop** if infestation is severe
- **Low production** and **sun scald of fruit**
- **Stained fruits** with Aphid excreta

Control:

- **Introduce natural enemies**, such as **Ladybird Beetle, parasitic wasps such as *Aphidius transcaspinus* (“APHITECH”)**
- Spray with insecticides, such as Acetamiprid (PRESENTO 200 SP®), Thiacloprid 480 g/L (CALYPSO SC 480®)

3.6.1.C: Cutworm

Cutworm larva

3.6.1.C: Cutworm

Identification:

- **Many species** of cutworm exist
- They are **grey**, **brown** or **black soft-bodied**, **smooth larva** of a large family of moths
- They **curl-up tightly** when disturbed
- They feed **at night**

Symptoms:

- Cutting of **the stems at the base**

3.6.1.C: Cutworm

Control:

- **Remove** by **hands** since the pest is easily found near the damaged plant, especially at the **beginning of infestation**
- **Manage Weeds:** early weeding destroys sites for egg laying
- **Plough the field:** ploughing exposes the pest to its predators and desiccation

3.6.1.D: Thrips

Thrips on a Chili leaf

3.6.1.D: Thrips

Identification:

- **Extremely small**, **long**, **thin**, **brown/black insects** with piercing (sucking mouthparts)
- They **suck** sap from plants and can produce a new generation **every 2 weeks**

Symptoms:

- **Silver** or **grey-white spots** with **black faecal dots**
- **Small warts** on the underside of leaf caused by egg deposition
- Distorted leaves that **curl upward**

3.6.1.D: Thrips Cont'

Symptoms Cont':

- Damaged fruits appear **brown** or **silver at areas near the calyx**
- Heavy infection causes **premature wilting**, **delay in leaf development** and **distortion of young shoots**

Control:

- **Plough** and **harrow** before transplanting to kill pupae in the soil
- Use of pesticides such as Spinosad (**Tracer 480 SC®**), Thiocyclam (**Evisect S®**), Diazinon (**Diazate 540EW®**)

3.6.1.E: Red Spider Mite

Red Spider Mite on a leaf

3.6.1.E: Red Spider Mite

Identification:

- Red Spider Mites are **minute 8-legged reddish**, **greenish** or **yellow** moving dots on underside of leaves

Symptoms:

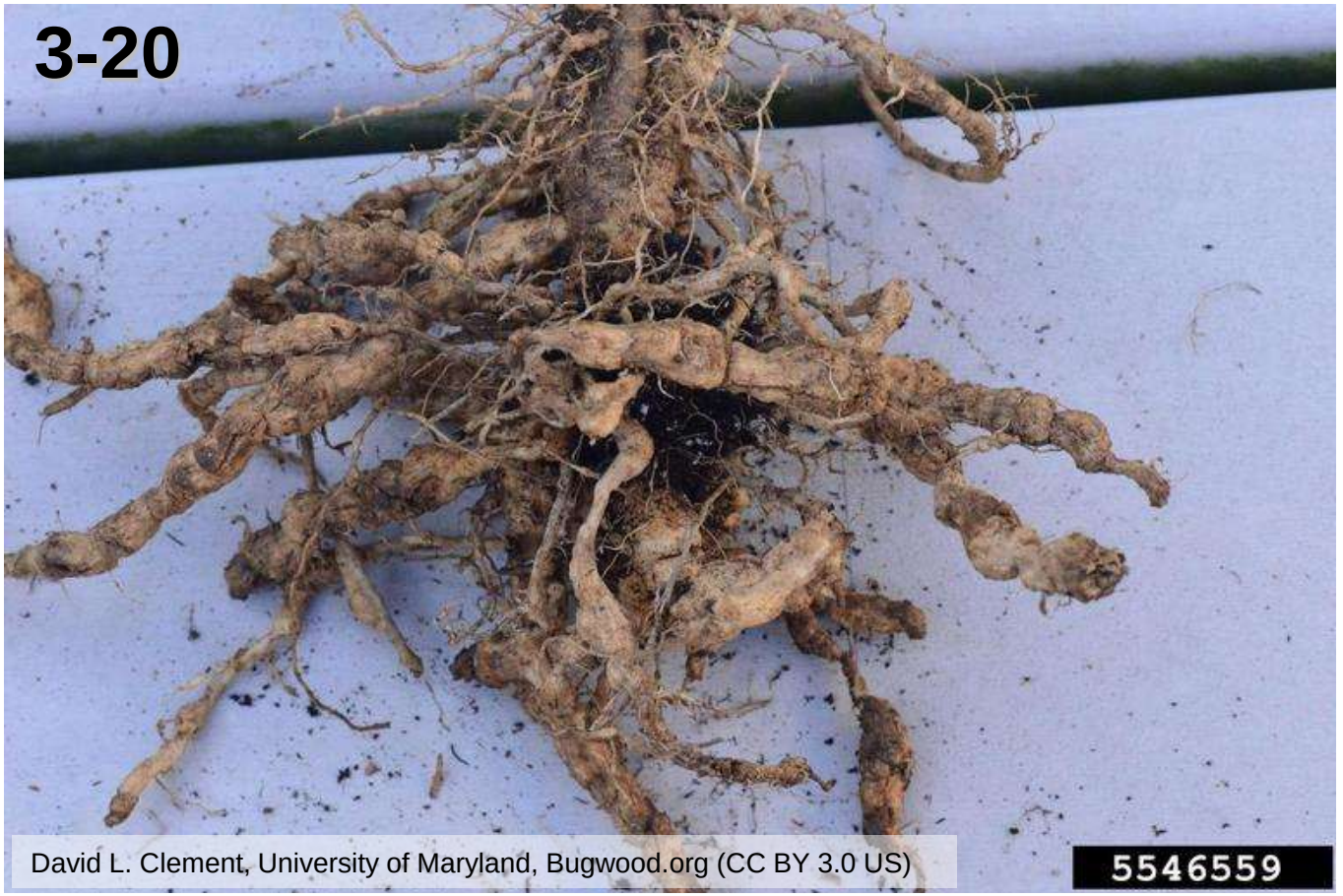
- **Leaves curl downwards** (inverted spoon)
- A **bronzed** (golden brown) or **russeted appearance** on leaves and fruits
- If uncontrolled, **plants die**

3.6.1.E: Red Spider Mite

Control:

- Apply pesticides such as: **Diazate 540EW** (a.i. Diazinon) and **neem oil formulations**
- Mites **rapidly develop resistance** to pesticides. To avoid development of resistance, farmers need to:
  - Use **miticides** such as Amitraz (Mitac 20EC®)
  - Avoid **preventive spraying**
  - Use **the recommended dosage**

3.6.1.F: Root-knot Nematode



Symptom of infested roots: Galls (swellings on roots)

3.6.1.F: Root-knot Nematode

Identification:

- Nematode is **microscopic**, **eel-like roundworm** that live in the soil and **feeds on roots**
- They cause physical damage that interferes with **uptake of water & nutrients** and allow **establishment of other diseases**

Symptoms:

- **Galls** (swellings) on roots: injury is more severe in **Sandy Soils**
- **Plant stunting** and **leaf wilting**

3.6.1.F: Root-knot Nematode Cont’

Control:

- Practice **crop rotation**
- Mixed cropping with **African Marigold**
- **Maintaining high levels of organic matter** in the soil, especially in Sandy Soils
- Use some bio products e.g.) **Neem extracts**

3.6.2 Major Diseases & Physiological Disorders

- The following are the major diseases and physiological disorders of Chili in Kenya:
  a. **Damping-off**
  b. **Anthracnose**
  c. **Powdery Mildew**
  d. **Chili Mosaic**
  e. **Fusarium Wilt**
  f. **Bacterial Leaf Spot**
  g. **Phytophthora Blight**

3.6.2.a: Damping-off

Photo: © A.A. Seif, icipe http://www.infonet-biovision.org/PlantHealth/Pests/Damping-diseases

“Damping-off” symptoms on seedlings

3.6.2.a: Damping-off

General Descriptions:

- This disease is **soil borne**

Symptoms:

- Seedlings killed before emergence
- **Water soaking** and **shriveling of emerged stem**

Control:

- Avoid siting seedbed on infested field
- **Avoid excessive fertilization** and **watering** to young seedlings while still at nursery bed
- Soil drenching with Metalaxyl-M + Mancozeb (**AMIDIL 68WG®**) as per label directions

3.6.2.b: Anthracnose

Photo: Rui map Zheng, Bugwood.org (CC BY-NC 3.0 US)

Anthracnose on a pepper fruits

3.6.2.b: Anthracnose

General Descriptions:

- The disease spreads rapidly **during wet weather**, in high temperatures and is **normally dispersed by a splash**
- The disease is **seed-borne** and infection is more likely to arise from **debris** or **old fruits**

Symptoms:

- **Dark**, **round**, **sunken necrotic tissues** which reach an inch in diameter
- **Dark raised specks** are produced in the spots which contain spores

3.6.2.b: Anthracnose Cont'

Note:

- Severe losses occur **during rainy weather** if timely control is not initiated

Control:

- Use **clean seed**
- Practice **crop rotation**
- **Mulching** to minimize **water splash**
- **Spray fungicide** during favorable environmental conditions e.g. Propineb (Antracol WP70®)

3.6.2.c: Powdery Mildew

Photo: © A. A. Seif & B. Nyambo, icipe
http://www.infonet-biovision.org/PlantHealth/Crops/Peppers#

Powdery white growth on underside of Chili leaves

3.6.2.c: Powdery Mildew

General Descriptions:

- The disease is characterized by **white fungal growth** on the lower leaf surface leading to **defoliation**, hence fruits are **sun burned**
- This problem normally occurs **late in the season** and results in reduced photosynthetic activity with **a consequent yield loss**
- It is a serious problem **if irrigation is mismanaged**

3.6.2.c: Powdery Mildew Cont’

Symptoms:

- **Powdery fungal growth** on the underside of the leaves
- The upper leaf surface of infected leaves may show **a yellow or brownish** colour
- The edges of infected leaves eventually **roll upward**, exposing **the fungus discoloration**

3.6.2.c: Powdery Mildew Cont'

Control:

- **Sanitation practices** (removing and destroying infected crop debris and weed control) in and around Chili fields
- Spray with fungicides e.g.) **Sulphur** (Thiovit Jet®, COSAVET DF®, FLOSUL PLUS®, **Sulfur dusts** (sulfur dusts can be used on organically grown Chili)

3.6.2.d: Viral Diseases

Photo: Florida Division of Plant Industry , Florida Department of Agriculture and Consumer Services, Bugwood.org (CC BY 3.0 US)

Cucumber Mosaic Virus infection

3.6.2.d: Chili Mosaic

General Descriptions:

- The disease is transmitted by **vectors**

Symptoms:

- **Light green** and **dark green patches** on the leaves
- **Distortion of leaves**
- **Stunted plant growth** during early stages
- **Yellowing**, **chlorotic ring spots** on leaves and fruits

3.6.2.d: Chili Mosaic Cont'

Control:

[CMV Origin]

- Control Aphids

[TMV, Pepper Mild Mottle Virus (PMMV) Origin]

- Soil bourne→ Crop rotation
- Seed bourne→ use of clean certified seeds

[All]

- Contact→ extra care during field activities
- Eliminate **weed hosts**
- **Rogue out** and **burn** affected plants including **alternative hosts** immediately

3.6.2.e: Fusarium Wilt

Photo: © A. A. Seif & B. Nyambo, icipe
http://www.infonet-biovision.org/PlantHealth/Crops/Peppers#

Chili infected with "Fusarium Wilt"

3.6.2.e: Fusarium Wilt

General Descriptions:

- The fungus lives indefinitely in the soil and is **spread through irrigation water**
- It is very susceptible to changes in temperature and soil moisture
- The optimum temperature for disease development is **24°C – 27°C**
- **Soil moisture** has the greatest influence
- The wilt **does Not** occur in dry soil, but it is serious **in poorly drained fields**

3.6.2.e: Fusarium Wilt Cont'

Symptoms:

- **Drooping** and **yellowing** of lower leaves followed by **wilting of the entire plant**
- Leaves on infected plants remain attached and the vascular system of the plant is **discoloured**, particularly in the lower stem and roots

Control:

- **Crop rotation** ensuring land is free from *Solanaceous* crops for 3 years
- **Improve drainage**
- Use **resistant varieties**

3.6.2.f: Bacterial Leaf Spot

Photo: Howard F. Schwartz, Colorado State University, Bugwood.org (CC BY 3.0 US)

Leaf spot on the leaves of Chili

3.6.2.f: Bacterial Leaf Spot

General Descriptions:

- This disease is **seed-borne**

Symptoms:

- The leaves exhibit **small circular** or **irregular dark brown** or **black greasy spots**
- As the spots enlarge in size, the center becomes **lighter** surrounded by **a dark band of tissue**
- The spot coalesce to form **irregular lesions**
- Severely affected leaves become **chlorotic** and **fall off**

3.6.2.f: Bacterial Leaf Spot Cont’

Symptoms Cont’:

- Petioles and stems are also affected
- Stem infection leads to **formation of cankerous growth** and **wilting of branches**
- On the fruits, the disease causes **small blister-like irregular spots** which later **turn brown** and develop **a warty appearance**

3.6.2.f: Bacterial Leaf Spot Cont’

Control:

- Use of **certified seed**
- Avoid siting seedbed on **infested field**
- Avoid **excessive fertilization and watering** to young seedlings while still in a nursery bed
- **Crop rotation**
- Spray **copper based fungicides e.g.** Copper oxychloride (**Amicop 50WP®, Cobox 50WP®**)

3.6.2.g: Phytophthora Blight

Photo: By Don Ferrin, Louisiana State University Agricultural Center, Bugwood.org (CC BY 3.0 US) - Forestryimages.org, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=17112413

Symptom of "Phytophthora Blight" on a Chili plant

3.6.2.g: Phytophthora Blight

General Descriptions:

- The **highly destructive disease** becomes a serious problem during periods of **heavy rainfall**
- It affects both **young seedlings** and **mature plants**

Symptoms:

- **Young Seedlings:** typical **Damping-off symptoms**
- **Mature Plants: water-soaked**, **dark brown lesions** on the lower stems expand to girdle the stems

3.6.2.g: Phytophthora Blight Cont’

Symptoms Cont’:

- Sudden wilting of foliage
- Infected leaves develop **circular** or **irregular**, **dark green**, **water-soaked lesions** which dry and appear **light tan**
- A mass of white fungal growth may develop **inside the fruit and seeds** usually turn **dark brown** or **black**

3.6.2.g: Phytophthora Blight Cont'

Control:

- Use only **certified**, **disease-free seed** or **transplants** (**seedlings**)
- Produce Chili plants on **raised beds** to retard initial stem infection
- **Practice crop rotation**, so that Chilies are grown only every 3 to 4 years
- **Application of fungicides** e.g.) Copper Oxychloride 50% metallic copper (**COBOX 50 WP®, AMICOP 50WP®**) may reduce disease development

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- Harvesting time is usually determined by **the fruit colour** required by the market
- **Maturity Period:** First harvest starts **2.5 – 3 months after transplanting** and continues for a further **4 – 6 months**

Harvesting:

- Mature fruits are **handpicked** and placed in a shade **to prevent shriveling**
- Fruits should be handled with care **to avoid bruising**
- **Yields: 4,000 – 6,000kg per acre**

5. Post-Harvest Handling

Storage:

- Chili is **pre-cooled** to **7 – 10 ºC**
- Chili can be stored for **3 weeks** at temperatures of **7 – 10 ºC** and Relative Humidity of **90 – 95 %**

5. Post-Harvest Handling Cont'

Photo: SHEP PLUS

Dried Chilies

5. Post-Harvest Handling Cont’

Drying:

- Chilies **should NOT be picked** until it starts going red
- Done in **open air** in raised racks and spread on **well-aerated polysacks** for up to **3 to 4 days** during the hot days or by use of special enclosed **solar cabinet dryers** to ensure fast and absolute hygiene
- The **moisture contents of Chili** when stored should be **10 – 15%** to prevent mold growth

5. Post-Harvest Handling Cont'

Drying Cont':

- With lower moisture content **(< 10 %)**, pods may be **so brittle** that they shatter during handling. This causes **losses** and **the release of dust**, which is irritating to the skin and respiratory system
- A Relative Humidity of **60 – 70 %** is desirable

5-5

Dried ABE Chilies

Reference

- The proposed agrochemicals are in accordance with “Products Registered for Use on Crops Version 1_2018”. The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.
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THANK YOU

ASANTE SANA

DOMO ARIGATO GOZAIMASU

Contact: SHEP PLUS Office (4th Floor, N.H.I.F. Building, Upper Hill, Nairobi)
Tel. No: 0737-293867/0712-504095
E-mail: info.shepunit@gmail.com