A REPORT ON CONVENTIONAL PINEAPPLE PRODUCTION IN KENYA

A photo of a large scale conventional pineapple production farm in Kenya

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i) Acknowledgement
The successful completion of this report has been made possible by contribution of various professionals working with stakeholders in Kenya. These include those from NGOs, CBOs, private companies, and communities’ leaders. The support of staff from Swedish Society for Nature Conservation (SSNC) team was immense and hence aided in the successful completion of the task. The support by respondents especially from the community members who were part of several focus group discussions, current and former staff from the pineapple farms are also appreciated highly. Other respondents who assisted in providing information such as NEMA official and County Public Health Officer are also appreciated.
ii) Executive Summary
This report outlines the outcomes of the study on conventional pineapple production in Kenya. The study was carried out with the aim of getting a deeper understanding of conventional pineapple production especially the agronomic practices in order promote good pineapple production practices in Kenya. The study was undertaken in selected conventional pineapple farms in Kenya where current and past workers were interviewed. Other information sources included surrounding communities, NEMA offices and health centre facilities near the farms. The following were the main findings:

**Land preparation:** In general, the farms are highly mechanized. The main activities carried out during land preparation include bush clearing, knock down, fluffing, burning trash, ripping and dragging, ploughing, soil conditioning, harrowing, ditch layout and cutting, field layout, rock removal, fumigation and mulching. The chemicals used at this stage include: glyphosate, paraquat, sulphur, lime, brimstone, rock phosphate and Telone II.

**Cultural practices:** The main cultural practices carried out include: seed preparation and treatment, planting, spraying, crown fertilizer application, weeding, irrigation and harvesting. The most prominent pests and diseases are mealy bugs, wire worms and rotting. The chemicals used at this level include diuron, bylaton, vydate and hyvar.

**Workers’ rights and social issues:** The companies have elaborate working policies on workers’ rights, health and safety. The main categories of workers are casuals, temporary and permanent. Workers have benefits such as education for children, housing, pension, gratuity, travelling and medical allowance. There is however a concern on retrenchments of workers carried out without transparency.

**Waste management:** The companies have complied with the relevant legislation on waste management. However the following noncompliance cases were identified: waste management discharge, burning/dumping of polythene/tetra pack, burning of plant waste and fly dust emission from processing.

**Impact to the surrounding communities:** The companies provide employment opportunities to local population though most of the workers are from distant Counties. The
communities expressed dissatisfaction with the farms due to low presentation in the employed people and on other issues of landlessness, chemical pollution, decline in water levels in the river and decline in aquatic life in the local water sources.

**Impact on health workers:** Due to the sensitivity of the information required from the health facilities, the workers refused to cooperate and therefore no information on impact of the farming practices on health of workers was accessed.

**Market:** A large percentage of pineapple production is exported mostly to European countries. Some farms concentrate on local market which has a growing potential, mostly fruits which are exported as processed fruit concentrate or canned, whereas local market mostly absorbs fresh fruits.

**Recommendations:** In general, there is heavy usage of chemicals in pineapple production. Most of the chemicals used are very toxic and have a harmful effect to the environment especially aquatic ecosystem and pollinators. The companies should therefore have a proactive and deliberate plan of reducing the usage of these chemicals through a continuous improvement programme to reduce the harmful impact to the environment. One of the chemicals used in pineapple production for fumigation is restricted for use in Kenya and only allowed to be used by Delmonte Company. This chemical should be banned due to its high level of toxicity. More study should be carried out to expose its short and long term effect. In addition, the companies should develop a responsible pineapple production threshold and monitoring system that will enable continuous improvement in reducing negative impact of pineapple production to the environment and surrounding communities.
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<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBOs</td>
<td>Community Based Organizations</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
</tr>
<tr>
<td>EMCA</td>
<td>Environmental Management and Coordination Act</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>Ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>MT</td>
<td>Metric Tonnes</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Environmental Management Authority</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>PCPB</td>
<td>Pest Control Products Board</td>
</tr>
<tr>
<td>SNA</td>
<td>Sodium salt of Naphthalene acetic acid</td>
</tr>
<tr>
<td>SSNC</td>
<td>Swedish Society for Nature Conservation</td>
</tr>
</tbody>
</table>
Limitations of the study

The current conventional pineapple production in Kenya by large scale companies is highly controlled with a lot of investment to curtail accessibility by un-allowed persons due to theft and negative publicity. Accessing workers willing to be interviewed therefore is difficult with most employees fearing reprisals from the companies’ management. The current negative publicity which has resulted to reduced market has made more stringent measures to be put in place in order to control any intruders who may be seeking information or taking photos/images of the commercial pineapple farms. In some companies, there are also 24-hour surveillance using CCTV cameras which limited access of photographs and other production related information. The access of information from the health centre under sponsorship of one of the companies was extremely difficult since the health workers were unwilling to give information without express permission from the company.
1.0 Background
The study on Conventional Pineapple Production in Kenya was commissioned by Swedish Society for Nature Conservation (SSNC) with the aim of getting an in depth knowledge of the differences in production systems between conventionally and organically produced pineapples. The study was being conducted concurrently with a similar study in the Philippines, Asia. The resulting reports would draw the differences between organic and conventional production methods with respect to agronomic practices: land preparation, preparation of planting materials, tillage methods, cropping systems, weed management, water management, soil fertility management, pest and disease management, and post-harvest management. The study would further compare the local, national and international markets for both the conventionally and organically produced pineapples and/or pineapple products. These would then be shared to contribute to the body of knowledge relating to the differences between the two production systems. It was also to be shared with stakeholders in order to create awareness, promote good pineapple production practices and hence enhance production of healthy pineapples.

1.1 Objective of the study
The purpose of the study is to evaluate conventional pineapple production systems in Kenya with a view of getting a deeper understanding of the agronomic practices, inputs used and their impact to the environment and the community.

1.2 Methodology
Data was collected from two large scale farms selected purposively due to their location, scale of operation and convenience. To understand the agronomic practices and operations in the selected pineapple farms, several current and former employees were interviewed. The employees had worked as either field managers or supervisors and had experience of working in the field making them to have extensive knowledge of the operations of the farms. The snowball technique was used to identify the respondents, while oral interviews were carried out privately to protect the identities of the respondents due to fear of reprisal from the companies. Three community members living downstream of the farms and three living upstream were selected purposively considering convenience and willingness to participate in the study. The impact of the pineapple farms on social and environmental
effects was also investigated to understand the concerns that the communities had on their existence with regard to the two aspects. A focus group discussion was carried out with each community representatives at Makenji trading center and Happy Valley along the Thika Garissa road for the upstream and downstream studies respectively. Further investigation was done on compliance with relevant environment laws namely the EMCA Act of 1999, by visiting the NEMA offices in Thika town of Kiambu County; and Nairobi to establish the compliance level in water disposal, waste disposal and management. An interview with a health centre affiliated with one of the pineapple producers was made to establish linkage between chemical exposure and incidences of diseases among the workers.

1.3 Introduction
Globally, pineapple is the second most traded product after bananas. There exists several hundred varieties, but the most widely grown are smooth cayenne, Queen and the recently (in the past decade) introduced variety called MD2 which commands 80% of the global trade in pineapples. Pineapple production is concentrated in the tropical regions of the world. It is grown in over 82 countries with over 2.1 million acres under the crop according to FAO, (2009) with a global production of 15,287MT. The main producers are Thailand, Philippines, Brazil, China, India, Costa Rica, Nigeria, Kenya, Mexico, and Indonesia. In Kenya pineapple is predominantly grown by large scale producers and small scale farmers. Large scale production is concentrated in Central Kenya where intensive inputs are used, while the small scale production is concentrated at the Coast, Central and Western Regions of the country; characterised by small farms with low input use (Chemonics International Inc., 2013). Pineapples are either sold as fresh fruit or are processed into a number of products with pineapple concentrate/ juice accounting for 80% of the trade.

Pineapple production in Kenya is dominated by three farms; Delmonte (K) limited based in Thika, Kakuzi Limited based in Muranga, Ndemo farm based in Kilgoris. These large scale producers contribute to close to 90% of all pineapples grown in Kenya. Medium scale and small scale producers account for about 10% of the total pineapple production. Small scale production takes place at the Coast (North of Malindi), the lake basin, (Kisii, Homabay, 

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Kericho, Migori counties) and in Central Kenya (Gatundu and Thika districts) in Kiambu County. Kakuzi has a total of 100 Ha under pineapple while Delmonte has 18,000 Ha and Ndemo farm has 200Ha under pineapple production respectively. Most of the land utilized for pineapple production by Delmonte and Kakuzi is under long term lease from the Government. The most common varieties produced by these farms are smooth cayenne, MD2 and Sweet 16. According to Koech et al., (2013), the most planted variety is smooth cayenne accounting for 80% of the total pineapple produced, though currently there are efforts to move to MD2 variety due to its superior nutrition qualities.

2.0 Study Findings

2.1 Land preparation
Whereas smallholder pineapple production systems do not include mechanization or use of external inputs, the large scale conventional farms are highly mechanized and use a lot of external inputs; pesticides and fertilizers. The process of land preparation in large scale conventional operations can be summarized by figure 1 below:

![Figure 1: A Summary of land preparation practices](image)
**Bush clearing** is done using a crawler tractor, dozer or a grader. When opening new grounds, a dozer is used to fell down trees and bushes. Stumps are dug using a dozer and a bucket loader with special tool used to lift stamps, where they are cut into pieces and burnt for charcoal. Stumps and loose rocks are usually pushed with a dozer to the edges of the field and the grass vegetation is burned. Where it occurs that fields have couch grass, they are sprayed with non-selective herbicides such as *glyphosate* and later burnt.

**Knock down** is done to uproot the pineapple plants and cut them into pieces. It is usually done by prime movers (large wheel tractors and crawlers) using light and heavy harrows; and stem cutters. The uprooted plants are chopped into small pieces and left to dry. After drying, *paraquat* is applied and then single pass of light harrow is done.
Fluffing involves churning the knocked and partially dried pineapple trash to facilitate drying. This practice is carried out during dry seasons where the trash in the underneath is exposed for faster drying. This is done using large and medium wheel horse power tractors and harrows. Burning of trash is done to get the field rid of any matter. This is done to the already dried up trash. After burning of trash, ripping follows using crawler tractors to achieve deep and fine tilth. Ploughing is generally made using two types of ploughs: big mould board and small bottomed mould board. When ploughing is done, top soil is turned upside down, the remaining trash is buried and the underneath layers of the soil turned upside down. After ploughing, ripping is repeated to achieve fine tilth.

Before commencement of planting, soil is conditioned using sulphur, lime, brimestone and rock phosphate. Sulphur is used to lower Ph while lime, brimstone and rock phosphate are used to increase the Ph. Additionally, compost made from pineapple waste is spread and later mixed with the soil through ripping or harrowing. This is done to break the soil clods into fine particles, pulverize the soil and churning the remaining trash. Additional harrowing is done where soils are cloddy. To manage runoff water, both collector and tertiary ditches are made using motor graders and ripping is done using rippers followed by harrowing using a light small harrow. The clods along the ditches are pulverized using a rotary harrow. Normally, tertiary ditches are cut using mouldboard plough mounted on a small wheel tractor or excavator.

To prepare the ground for planting, layout is done to establish where the pegs will be made. Planting beds are made at a spacing of 45”x100ft long. Planting is made by blocks of

Paraquat is a trade name for N, N’-dimethyl-4, 4’-bipyridinium dichloride which is a toxic chemical that is widely used as a non-selective herbicide (plant killer), primarily for weed and grass control. It is available primarily as a liquid in various strengths. In many countries it is classified as “For restricted use.” Paraquat is highly poisonous to humans when ingested or when it comes into contact with the body. When it enters the body, it is distributed to all areas of the body. It causes toxic chemical reactions to occur throughout many parts of the body, primarily the lungs, liver, and kidneys. This may lead to heart failure, kidney failure, liver failure and lung scarring.
30m after which an alley path of 3ft\(^1\) is made. In a field block, there are 10 blocks of 32 beds wide by 1030ft (314m) long (depending on the configuration). To remove rocks, a crawler with the dozer is used to push the boulders from the field to the edges of the field. Sometimes workers are involved in loading rocks on bucket loaders to take to the edge of the field.

![Image of field with plastic mulch]

After that, the field is prepared for planting where beds are made. The plastic mulch is laid down using a tractor. As shown in photo 2, the polythene has holes which mark where the pineapples slips, suckers or crowns will be planted. After that, fumigation for the fields is done using Telone II or DD95.

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\(^1\) Ft is a unit of length. 1 foot equals 12 inches which is equivalent to 0.3048 meters
1,3-Dichloropropene is a fumigant supplied by Dow agro sciences for use as pre-plant soil fumigant for control of all major species of nematodes, including root knot, lesion, stubby root, dagger, ring, and cyst nematodes. It has also been used as a herbicide. The chemical has been marketed in the brand names of Telone II, Telone EC, Telone 2000, Condor, Dorlone EC, D-D 95, DD Inyectable, D-D soil fumigant, DD 92, DD emulsifiable, and DD Top 90 EC. It is injected into the soil as a liquid and immediately converts to a gas, creating a zone of protection around developing roots. As a fumigant, it moves throughout the soil profile on its own, rather than requiring water or incorporation for movement. According to Rotterdam convention, when applied in a farm, its vapors travel a long distance especially in situations where there is wind drift. It has been banned in Europe for any use since 2007 (2007/619/EC directive) due to its highly toxic nature to human beings, fish and/or other aquatic organisms and its potential to cause cancer in humans. According to its Material safety data sheet, 1,3-Dichloropropene is highly toxic to aquatic organisms on an acute basis (LC50/EC50 between 0.1 and 1 mg/L in the most sensitive species tested). It is also moderately toxic to birds on an acute basis (LD50 between 51 and 500 mg/kg) and has a stratospheric ozone depletion potential (ODP) of 0.002.

Plate 3: A carrier with Telone II ready for application in the field
Telone II fumigant is applied at a rate of 222 litres per hectare and mostly to control nematodes. It is applied using fumigant tanks loaded in tractors. Where this is not accessible, mulching and fumigation is done manually using portable injectors.

The following is a summary of chemicals used in land preparation:

**Table 1: List of chemicals used in land preparation**

<table>
<thead>
<tr>
<th>Name of chemicals</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>As a non-selective herbicide</td>
</tr>
<tr>
<td>Paraquat</td>
<td>As a herbicide for grass weeds</td>
</tr>
<tr>
<td>Sulphur, lime, brimestone and rock phosphate</td>
<td>Used for soil conditioning (are allowed in organic farming)</td>
</tr>
<tr>
<td>Telone II</td>
<td>Fumigant to control soil borne pests such as nematodes</td>
</tr>
</tbody>
</table>

### 3.0 Field management activities

In the field the following management practices are carried out as shown in the figure below:

**Figure 2: A summary of field cultural practices**

- Harvesting
- Seed preparation and treatment
- Irrigation
- Planting
- Weeding
- Spraying
- Crown fertilizer application/side dress
3.1 Seed preparation and treatment

For any given planting material sorting is done to have uniformity of the materials and removing defected ones. The materials are supposed to be uniform. Sorting is initially done to separate slips, suckers and trash. After separation, the suckers are sorted using the following characteristics as unsuitable:

a) Thorny/spiny leaves  
b) Multiple heads  
c) Rotten  
d) Without heart  
e) Weight (below 140 gms)  
f) Pinkish red colouration

After sorting, the suckers are butted up by putting them together with their butts sideways and then piling them between the suckers while ensuring they are exposed to sunlight and are not damaged. The crowns (tops) are firmly placed between suckers to avoid falling off. Grading is done for crowns that are 140-250gms and those that are 251-350gms. For suckers, they are supposed to range between 300-750gms. For sleeves the size required is 200-500gms. The graded suckers are transported to a dip using trucks for treatment.

Once land is ready for planting, seed selection for specific land is carried out. The type of seeds to be planted depends on the season of the year, the availability of planting materials and the time when fruits are expected for the market. Once the planting materials are selected, they are hauled to the dip where they are immersed in a chemical solution which has pesticide-(Dursban), fungicide (bayleton/vydate) and sticker (aqua wet). In the solution, the seeds are immersed and kept for 3 minutes until they are fully soaked. The seeds are then removed from the dip through a conveyor to a tipper (lorry) which hauls the seeds to the field for planting. The seeds are dumped depending on the size of the plot and left to drain the chemical for two (2) days.
3.2 Planting

Planting is carried out manually using a planting iron. Every planter is given 32m x 16m area per day. The planting is done at the marks in the mulching polythene. There is no fertilizer applied during planting. Immediately after planting, irrigation follows within the first two (2) weeks. In most cases, overhead irrigation is used to firm the soil around the planting material. If the ploughing tilth was fine, drip irrigation is used. From planting, in the absence of rain, irrigation is done once per month until the crop is ready for harvesting in the 19th month. Most of this is done using overhead irrigation. The quantity of water applied is 20m³/month/ha.

Dursban is the brand name for an organophosphate pesticide (chlorpyrifos) that kills by attacking the nervous system. It is used for killing termites, cockroaches, ants, fleas and other insects. Dursban has been documented as an extremely dangerous chemical with negative effects on nervous system, disrupting functioning of endocrine system, potential to alter and interfere with the hormonal systems of insects, wildlife, and people. It also causes neurological damage to children and can result in blurred vision, fatigue, muscle weakness, memory loss and depression. The chemical is associated with carcinogenicity, reproductive and developmental toxicity, and acute toxicity. It is also documented to cause multiple chemical sensitivity, neurobehavioral problems and peripheral neuropathy. When pregnant women are exposed to Dursban in their first trimester this has been association with birth defects.

Vydate is a brand name of Oxamyl which is a Carbamate insecticide/ acaricide/nematicide that controls a broad spectrum of insects, mites, ticks, and roundworms. It may work both through systemic distribution in the target pest and on contact. It is mostly used on field crops, vegetables, fruits, and ornamental plants and may be applied directly onto plants or the soil surface. The chemical is highly toxic via the oral route, with cholinesterase-inhibiting effects in the short term. Other effects include headache, nausea, sweating, tearing, tremors, and blurred vision. Skin and eye exposure may cause poisoning, although absorption through the skin and eye is slower than through the gastrointestinal tract. It is highly toxic via the inhalation route. Oxamyl is very highly toxic to birds and bees.
3.3 Spraying

Spraying is usually carried out on a monthly basis following a monthly spray schedule. The chemicals sprayed include herbicides, hormones, fertilizers, insecticides, fungicides and nematicides. Spraying is done using a boom sprayer and a bowser. All chemicals are mixed in the bowser while hormones are mixed in the boom sprayer. Spraying is done both during the day and at night. Ethylene gas is applied using a boom ethylator when mixed with water and china clay. Ethylene gas is only applied at night.

Ethylene is a hydrocarbon with the formula C₂H₄. It is produced naturally by most fruits such as passion fruits, tomatoes, bananas, pineapples and avocados during ripening. It is widely used in agriculture as a natural hormone to promote ripening. Though research with lab animals has shown increased risk of cancer, its use by humans does not have any documented risk.

As a rule and part of safety guidelines, workers involved in spraying have blood samples taken to test cholinesterase level on monthly basis. Employees found with low levels are suspended from working with chemicals until its level improves. This is because the chemicals sprayed have adverse effect to nervous system when inhaled or ingested.

Serum cholinesterase is a blood test that looks at levels of two substances that help the nervous system to work properly. They are called acetylcholinesterase and pseudocholinesterase. Nerves need these substances to send signals.
Immediately after planting, a herbicide spray is applied to control both pre and post-emergence weeds. Mostly, hyvar a selective herbicide for broad leafed plants and glyphosate/diuron which is a systemic herbicide, are used. Spraying starts in the second month. This is to counter any pests or diseases that might have escaped the dip treatment. Mainly it is a pesticide (dursban) and a fungicide (vydate) that is sprayed. The next spray comes in month 4 with a foliar fertilizer which is mainly Urea. This is sprayed on the leaves using a boom sprayer. Another spray comes in the 6th month. This is composed of a pesticide (diazinon), fertilizer (NPK-17:17) zinc sulphate and iron sulphate or magnesium sulphate depending on soil analysis results. Magnesium sulphate is used for soil stabilizing when the Ph is high, while iron sulphate is used as a fertilizer. This is because they cannot be used together. The next spray is in month 8 where a foliar (Urea) and a pesticide (Dursban), iron sulphate and zinc sulphate spray respectively are applied.
Note: Foliar spray starts from month 4 to 9, and is done monthly. Both the foliar spray and insecticide spray are stopped immediately after forcing. **Forcing** is the inducing of flowering in pineapples and is mainly done based on the height and the age of the plant. The chemicals used in forcing are: ethylene gas + **urea** fertilizer. This is because Urea makes the stomata to open so that ethylene gas can enter. Forcing is also done using **sodium salt of naphthalene acetic acid (S.N.A)**. **SNA** are synthetic auxins used as cell media to induce flowering. In most cases, forcing is done between months of 10-12.

### 3.4 Crown fertilizer application/side dress

The side dress fertilizer is based on soil analysis results. Nutrient analysis in the soil and the plants are done monthly to ascertain the level of nutrient so as to determine the fertilizer to be used. At month 3, a phosphoric fertilizer (DAP) is applied at 9gms per plant to induce rapid rooting. Based on the soil analysis, at month 5 NPK 23:23:0 is applied at 10gms per plant. At month 7, CAN is applied at 8gms per plant.
**Note:** In the course of growth in the field should there be an area with poor growth, both soil and plant analysis are carried out and based on the result a suitable ground fertilizer is applied to correct the soil nutrient ratios.

### 3.5 Weeding

In most cases, there is minimal weeding. The mulching material and the initial herbicide spray control the weeds up to 5-6 months when weeds start emerging. Weeding is done manually using Jembes, forks or uprooting manually. Weeding continues until the ratoon crop is harvested based on the population of the weeds. When the weed population density is high, herbicides are applied with choice depending on whether the weeds are grasses or broad leafed. Where the weed population density is low (weeds are scattered) manual weeding is done.

**Confidor 70 WG** is a systemic water dispersible granule insecticide for controlling different pests including aphids, red scale, thrips, leaf miner and aphids and is distributed by Bayer crop science. According to EC regulation 1272/2008, Confidor 70 WG is rated as very toxic to aquatic life with long lasting effects. It is also classified as harmful, R22 and dangerous for the environment R50/51 (EU directive 1999/45/EC). Excessive exposure causes respiratory and cardiac malfunction in humans.

### 3.6 Pest and disease control

Throughout the growth of the pineapples, pests and diseases are controlled through preventive measures. A lot of effort is done on scouting and testing to diagnose diseases and pests infestation early as a way of ensuring maximum impact of control mechanisms and reducing damage of pineapples. The most common pests in pineapples include termite, mealy bugs, wireworms and white grabs. The common diseases include sclerotia, pineapple wilt, fuseriam, heart rot and bud rot. Prevention starts with treatment of planting materials with dursban and bylaton. This protects and controls soil born pests and diseases which can affect the young pineapple roots. Before planting, fumigation is done using **Telone II** to protect soil borne pests and diseases such as wireworms, white grabs and sclerotia. Other important pests are mealy bugs which are controlled using diazinon and dursban. Weeds are controlled using herbicides primarily glyphosate, hyvar and diuron. The following is a summary of the common pests and diseases and how they are controlled:
### Table 2: Pests and diseases during growing period

<table>
<thead>
<tr>
<th>Pest</th>
<th>Part affected</th>
<th>Stage</th>
<th>Chemical for controlling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termite</td>
<td>Roots</td>
<td>Throughout the growth</td>
<td>Confidor 70WG</td>
</tr>
<tr>
<td>Mealy bugs</td>
<td>Roots and leaves</td>
<td>From planting to maturity</td>
<td>Dursban, diazinon</td>
</tr>
<tr>
<td>Wireworms</td>
<td>Roots</td>
<td>Throughout the growth</td>
<td>Telone II, Diuron.</td>
</tr>
<tr>
<td>White grabs</td>
<td>Roots</td>
<td>Maturity (Ratoon stage)</td>
<td>Telone II, Diuron.</td>
</tr>
<tr>
<td>Sclerotia</td>
<td>Roots</td>
<td>Maturity (Ratoon stage)</td>
<td>Telone II, Diuron, bylaton.</td>
</tr>
<tr>
<td>Pineapple Wilt/Fusarium</td>
<td>Leaves</td>
<td>Maturity (Ratoon stage)</td>
<td>Telone II, Diuron, bylaton.</td>
</tr>
<tr>
<td>Heart rot</td>
<td>Leaves</td>
<td>Young stage (Month 1-6)</td>
<td>Vydate</td>
</tr>
<tr>
<td>Bud rot</td>
<td>Entire plant</td>
<td>Young stage (Month 1-6)</td>
<td>Vydate</td>
</tr>
<tr>
<td>Weeds</td>
<td></td>
<td>Throughout</td>
<td>Glyphosate, diuron, hyvar</td>
</tr>
</tbody>
</table>

### 4.0 Ratoon crop Management

Ratoon crop is the crop that comes after plant (main) crop i.e. after the first harvest in the 19th-20th month. The production of ratoon crop is usually lower than the main plant crop. The main activities in ratoon crop are de-suckering, stripping, weeding, irrigation, spraying and forcing. Immediately after harvesting an insecticide (Dursban) is sprayed to counter any insect build up during the fruiting season. In month 21, a foliar spray is applied mainly with urea, zinc and iron sulphate. This is done to provide the key nutrients required to rejuvenate the pineapples: iron, nitrogen and zinc. In the same month stripping is done where the slips are removed (should they be needed for planting they are sorted and treated). After stripping, de-suckering is done to leave one sucker per plant depending on the sucker density. Should there be poor sucker development; some plants can be left with two (2) suckers. The suckers are the ones to carry the ratoon crop (fruits).
Since planting, irrigation is done on a monthly basis unless it rains to the equivalent of the quantity of water applied. During each of the irrigation session, a total of 20 m³/ha is applied from the first month until harvesting in month 30-32. For the ratoon crop, forcing is done on month 25-26 depending on the height of suckers and the age. Immediately after forcing no sprays are applied to the ratoon crop. After 30-32 months, harvesting is done to conclude the production of the crop. After completion of harvesting, the plants are knocked down to start off preparation for planting again. The field is thereafter left for one year (8-12) months without any activity before commencement of the next cycle of the crop.

5.0 Harvesting
Before harvesting commences, yield estimates are projected for weekly production for both long term crop and ratoon crop showing tons per Ha and percentage fruit size distribution per density of planted area. Weekly estimates are done three months to peak harvest and done continuously until all the fruit is cleared. This is compared to the annual and 5 year estimated production. If more than 20% of the fruit is ripe, then estimates are considered for the peak season. Estimates are done for the 3 common grades; IT, 2T and 2½T. The fruit density also guides on whether to use a boom harvester or not. Where the density is high; above 11.2 tonnes/Ha, the boom is used, but below that hand harvesting and loading is done. Pineapples are generally harvested in 3 categories:

a) Boom harvesting for processing

b) Hand harvesting for cannery fruits

c) Hand harvesting for fresh fruits

Harvesting is done during the day and at night. The pickers fill fruits on crates through conveyors of the boom. Before commencement of harvesting, workers are generally trained on how to pick fruits, select the ripe ones, and remove crowns and separate fruits and crowns when putting on the boom conveyors. The training also includes health and safety. Each harvester is issued with rain coats, canvas trousers, arm sleeves and gumboots as protective clothing. For hand harvesting, each harvester is supposed to harvest 60 fruits per
hour. Hand harvesting is made per order received with a 5% increase to cater for damaged fruits. Sometimes hand harvesting is done with bags/canvas or mass depending on demand. The fruits are loaded to a waiting lorry for transportation to the factory. A lorry usually carries 7-9 tons.

6.0 Post harvest handling and processing
Due to the limitation of accessing information from staff working/past workers in the processing facility, the information gathered regarding processing was scanty. Once the lorry reaches the cannery, the weight is taken. The lorry thereafter goes to the sampling station where 50 fruits are taken randomly and used to assess the sizes, ripeness, porosity, brix\(^2\) content and damages of the fruits. When the features do not meet the requirement, they are rejected. After that the crates are disembarked and hanged at the hanging station waiting processing. At the commencement of the processing, the crates are offloaded and washed in a conveyor to clean any foreign matter. Through the conveyor, the fruits go to the cannery as they get the final washing. The fruits are then graded according to their sizes (1T, 2T, and 2\(\frac{1}{2}\)T) where the less than 1T are used for juicing. The 1T, 2T and 2\(\frac{1}{2}\)T are cut into pieces for canning. The cut pineapples are hand graded and manually packed into tins. The tins are taken into the boiler for disinfection and final packing. A sample of canned pineapples is taken for final testing and quality control. Fresh Fruits are normally packaged in six (6) per carton or sold as loose since some customers order loose fruits and therefore get package as loose fruits in their cars or containers.

7.0 Workers rights and social issues
From the discussion with the respondents, there seems to be no incidences of discrimination on sex, ethnic background, political affiliations or religious beliefs. The policies in use for controlling coerced and child labour are well documented in the companies’ policy documents and are followed. There also seems to be adequate measures put in place to ensure safe and healthy working environment through protective clothing, though the risk of prolonged exposure of dangerous chemicals used in the farms may affect the general

\(^2\) Sugar content, measurement of sucrose in the juice
health conditions of the workers. Workers interviewed also agreed that there is respect for workers rights with existence of collective bargaining system, absence of corporal punishment, mental or physical coercion, sexual harassment and verbal abuse. The respondents however noted that the companies usually put heavy punishment for such behaviors reported to the authorities. In addition, there were reports of adhoc retrenchments precipitated by increased market constriction.

The pineapple farms’ studies shows that they contribute significantly to providing employment opportunities to the local population. In total, they employ close to 6,000 employees 10% of whom work under permanent status. Other categories of workers include seasonal workers (under 6 months’ contract which is renewed after payment of gratuity) and casual workers who work on 3 months’ renewable contract after a break of 2 to 3 weeks. The following is a summary of the benefits accrued by the different categories of the farmers:

Table 3: Summary of workers benefits

<table>
<thead>
<tr>
<th>Category of workers</th>
<th>Benefits</th>
<th>Salary range (Monthly rate in Ksh)</th>
</tr>
</thead>
</table>
| **Permanent: Management** | • Medical insurance for all members of the family  
• Education of all the children up to post-secondary education  
• Pension  
• Gratuity  
• House allowance  
• Travelling allowance | 60,000 to 1 million |
| **Permanent: Regular** | • Medical insurance for 3 members of the family  
• Education of children up to secondary education  
• Pension  
• Gratuity  
• House allowance | 40,000 to 55,000 |
| **Seasonal contracts** | • Medical insurance for the                                             | 15,000 to 40,000 |
8.0 Waste management

In general the workers interviewed reported that the companies have put adequate measures to ensure proper waste management and disposal. It was noted that the waste water from processing units passes through sedimentation tanks where a substance composed of microorganisms is applied to aid in decomposition. After passing through different sedimentation tanks, the water is pumped back and recycled in the field where it is used for irrigation. The solid waste from the pineapples is usually given to local people for use as animal feeds. The remainder waste is usually heaped and allowed to decompose where it is later picked and taken to the field as manure.

To further investigate the management of waste by the companies, an interview was carried at the Thika sub-county National Environment Management Authority (NEMA) office to assess the level of compliance and reported incidences of environmental pollution by the pineapple producing companies in the local community. Compliance assessed included on waste management, chemical use, waste water management and the general environmental standards. The companies under study are compliant with the environmental standards required by NEMA. NEMA carries out occasional environmental audit and quality assessments including checking internal audits done by the company. Whereas the companies are compliant with most environmental standards, there are four areas of non-compliance that were noted in their audits filed at the NEMA office. These include:

a) Waste management discharge
b) Burning/dumping of polythene/tetra pack
c) Burning of plant waste
d) Boiler operations that emit fly dust
On waste water quality and waste water treatment, monthly water quality analysis is done in the internal lab, and quarterly by NEMA approved laboratories. The companies have elaborate waste water treatment plants where water is re-used for irrigation after completion of treatment. Occasionally overflows is allowed to the Samuru River during rainy season.

For general waste management, there is a documented procedure for waste management on site. The waste is usually recycled while others (hazardous ones) are incinerated. There is a system for monitoring the effluent quality on daily basis, and quarterly for NEMA reporting purposes. The reports noted that tetra pack waste has proved difficult to recycle so some are used in tree seedling planting. Biomass wastes on the other hand are dumped into the fields where it decomposes and used as manure.

The NEMA office also confirmed that industrial pollution from some of the other products' town based industries was affecting downstream river quality which in turn was affecting water supply quality for the downstream community.

9.0 Impacts to the surrounding communities

9.1 River and air pollution
There was no adverse chemical air pollution reported by the upstream communities. A look at the river shows characteristic change in colour and turbidity before and after passing through the farms. Majority of downstream communities attributed the declining river quality to a variety of non-point sources, including the many Thika based industries that are known to discharge effluent into the river. They cited chemical pollution, organic pollutants, declining water levels and the deaths of aquatic life as some of the notable changes in the river. Suspended solids were also pointed as pollutants. It was also realized that majority of the communities living downstream, about 15km from Thika town rely on the river directly for their livelihoods and domestic water use.
Plate 6: A section of dry river valley downstream

Plate 7: A section of one of the rivers upstream
Plate 8: A section of contaminated river downstream, such pools of water are used as fishing ground

9.2 Local attitude towards the pineapple farms
Majority of residents of Makenji locality are happy and satisfied with the activities of the pineapple farms. Some said that due to the activities of the farms, there has been employment creation and increased general economic activity in the area. On the other hand majority of the downstream communities (50%) are not satisfied with the activities of the farms as well as industries from Thika town. This is because residents attribute the poor river quality to the pineapple farms. Only about 25% are satisfied with activities of the farms. They also feel that the farms are responsible for the general decline in the level of water in the river which directly affects their livelihoods. Below is a graphical representation of the satisfaction levels of the communities as identified by the respondents:
9.3 Impact assessment of pineapple farms to the communities
The impact felt by the communities as a result of the activities of the pineapple farm was assessed to determine what the communities felt in terms of contribution of the farms to their welfare and livelihoods, chemical pollution of the environment (air and water), impact on biodiversity and social economics (employment creation). This was analyzed for all the respondents in the focus group discussion in the upstream and downstream
communities. The information was entered as a percentage of the total response to the total number of people interviewed, referred here as sensitivity (Table 4).

Table 4: Impact of pineapple farming activities to the community

<table>
<thead>
<tr>
<th>Area</th>
<th>Impact area</th>
<th>Sensitivity (responses out of 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream communities</td>
<td>Welfare and livelihoods</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Chemical pollution</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Impacts on biodiversity</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Employment creation</td>
<td>2</td>
</tr>
<tr>
<td>Downstream communities</td>
<td>Welfare and livelihoods</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Chemical pollution</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Decline in water levels</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Aquatic life decline</td>
<td>3</td>
</tr>
</tbody>
</table>

The table shows that generally upstream communities were less sensitive and had less impact from the farms as compared to the downstream communities. The pineapple farms had only significant impact to the welfare and livelihoods of the upstream communities. As expected, it had a bigger impact in the downstream communities as indicated by the high sensitivity of 4 in the areas of welfare, chemical pollution and declining water levels.

Plate 9: A section of the upstream pineapple farm
9.4 Land grabbing and landlessness
For the upstream communities the welfare concerns reported included the perceived grabbing of land by the farm thus rendering the locals landless. There was also noted impact of the farm on biodiversity though it was to a less extent. This has been contributed by clearing of land during land preparation, excessive chemical usage and burning thus interfering with the biodiversity.

9.5 Employment
The companies’ existence in Thika Sub County has created employment opportunities. Farms such as Delmonte have greatly influenced the lives of people especially near Makenji area through offering employment opportunities. However, majority of the interviewees claimed that much of the employment opportunities go to people from outside the Sub-county thus some felt that the farms have not helped much the immediate surroundings.

9.6 Pollution from town
Majority of the downstream communities have attributed the river pollution to a variety of sources including the industrial activities in Thika town, where a few pointed the agricultural farms upstream. It was strongly pointed by the interviewees that there was chemical pollution from the pineapple farm, negative welfare impact as well as decline in the water levels in the river.

10.0 Impact of pineapple production on health of workers
An interview was planned with the officials at a local health centre affiliated with one of the pineapple farms, Sub County public health officer and superintendent of Thika Level five hospital, which is at the proximity with the farms selected. The aim of the interview was to investigate any link between the incidences of health problems reported and the environmental impacts which are known to be emanating from the agricultural activities in the area. Despite making several attempts to access this information through interviewing the targeted respondents, it was not possible to obtain any substantial information to add to the study. From the perspective of the health workers, such information was considered extremely sensitive and this perhaps was behind the reluctance that was felt in sharing the information across all the targeted respondents.
11.0 Markets
Pineapples are graded into three categories according to diameter and the length:

1. Grade 1  12.7cm diameter, length 15.3cm
2. Grade 2  10.8cm diameter and length 13.3cm
3. Grade 2½  8.9cm diameter and 11.4cm length
4. Less than 2½  Less than 8.9 cm in diameter and 11.4cm in length

Pineapples for cannery are usually grades 1, 2 and 2½. Fresh market requires fruits with an average weight of 1.4 - 1.6kgms. Grading of pineapples for fresh market is based on appearance, colour, sweetness, aroma and size.

Kenya is among the largest pineapple exporter in Africa accounting for well over 30% in export volumes of canned pineapples. The total production of pineapples in Kenya is approximated to be in excess of 1.5 million tons annually. Out of this, Delmonte contributes the biggest share of close to 1.3 million tons while Kakuzi and Ndemo farm contribute each 7,000 tons and 16,000 tons respectively. The major markets of Kenyan pineapples include France, Germany, Italy, Belgium and Netherlands, Sweden and Denmark. For the 3 main players 99% of Delmonte production is exported. Kakuzi on the other hand focuses 100% on the local market but is working towards exporting. Ndemo on the other hand sells 70% of the fruits produced in the local market and 30% to export market. Other products produced by the pineapple producers include canned pineapples which make approximately 5% of Delmonte’s operation and juice concentrate which is largely exported, though there is some sold for juice making for the local national market.

12.0 Conclusion and Recommendations
Pineapple production is very significant to the economy of Kenya. Its contribution to the economy in terms of creating employment and foreign exchange cannot be ignored. Expansion of pineapple production system will therefore lead to more benefits to the economy and therefore should be promoted.

Pineapple market is vibrant and is the biggest in East Africa. This shows there is a big potential for expanding production to cater for the existing unexploited markets.
During the study there seemed to be a lot of restriction to information of production of pineapples. Whereas publicity for the companies will help in educating the consumers of the production system and create a market for pineapples, the secrecy of operations in the companies seems unusual.

From the study, it is evident that there is a lot of chemical usage (pesticides and fertilizers) in production of pineapples. Most of these chemicals have been found to be harmful to the environment. Although all the chemicals are approved for use in Kenya according to the PCPB, (2013), Telone II has been indicated as for restricted use only by Delmonte. Since this chemical is very toxic and has very devastating effects to human beings and the environment, its use should be stopped and alternatives used elsewhere sought. Although the pre-harvest intervals for chemicals are observed as shown by stoppage of chemical application 6 months before harvesting, meaning that there are no likelihood of chemical residual in the fruits, there are serious environmental threats to the chemicals applied. The impact to the environment is reduced biodiversity especially for pollinators, and reduced aquatic life in water bodies like rivers and dams. The companies should have a proactive and deliberate plan of reducing the usage of toxic chemical is pineapple production.

The impact of toxic chemicals used in pineapple production on workers is evident. Although the study did not manage to access information on incidence of diseases as a result of chemical spraying by workers, testing of cholinesterase level is evidence that the chemicals used have an impact to the health of workers. The companies should therefore develop a responsible pineapple production threshold and a monitoring system that will enable continuous improvement in reducing impact of chemical sprayed by workers. This can be done by bringing together actors of the pineapple value chain and other stakeholders together to explore the available sustainable opportunities.
During land preparation, burning of trash is a common practice. When done on large scale, it contributes significantly to greenhouse gas emissions. This practice should be discouraged and instead encourage composting in the field.

The interaction of the companies with the surrounding communities does not seem to be strong. Though there are strong indications of job creation in production and processing, there is need for the companies to invest in sustainable and long term community development programmes so as to create more positive interaction with surrounding communities and change their negative perception.

The companies have already carried out their respective Environmental Impact Assessment (EIA) as evidenced from the National Environmental Management office. The companies should work on continuous improvement for compliance in the identified areas of Waste management discharge, burning/dumping of polythene/tetra pack, burning of plant waste and fly dust emission from processing as identified by EIA audits done by the companies.

There is however need to carry out more study on the impact of the chemicals used on the farm to the soil, water and pollinators. This could include water testing to see whether the chemicals can be found on rivers. This will ensure that the communities living downstream of the processing plants, are not adversely affected by the pollution emanating from pollutants.

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3 EMCA Act requires companies to conduct environmental impact assessments and file the reports with NEMA.
Annex 1: References
Dupont (2010), Material Safety Data Sheet Hyvar X Herbicide, Dupont: Wilmington.
FAO (2009), The market for organic and fair trade mangoes and pineapples, FAO. Rome, Italy.
Moncada Adriana (2005), Environment fate of Diuron, Department of pesticide regulation: Sacramento.
NEMA (2010) NEMA/EIA/5/2/510; Proposed expansion of the pineapple project from 250 tonnes to 310 tonnes in Kanyanzavi division, Matungulu districts
### Summary of Pesticides Used and Status of their registration

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Status of Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>Registered PCPB (CR) 1098</td>
</tr>
<tr>
<td>Paraquat</td>
<td>PCPB (CR) 0029</td>
</tr>
<tr>
<td>Telone II</td>
<td>PCPB (CR) 0196 – For restricted use. Only allowed for use by Delmonte Co. Only</td>
</tr>
<tr>
<td>Confidor 70 WG</td>
<td>PCPB (CR) 0581</td>
</tr>
<tr>
<td>Dursban EC</td>
<td>PCPB (CR) 0021</td>
</tr>
<tr>
<td>Diazinon/Diazol</td>
<td>PCPB (CR) 0815</td>
</tr>
<tr>
<td>Diuron/Diurex</td>
<td>PCPB (CR) 0116</td>
</tr>
<tr>
<td>Vydate/Bylaton</td>
<td>PCPB (CR) 0358</td>
</tr>
<tr>
<td>Hyvar</td>
<td>PCPB (CR) 0072</td>
</tr>
</tbody>
</table>

\footnote{Registered by Pest Control Products Board as a pesticide in Kenya}
Annex 2: Discussion guide
A STUDY ON PINEAPPLE PRODUCTION SYSTEMS COMPARISON: ORGANIC AND CONVENTIONAL

Aim of the study

The purpose of the study is to evaluate conventional and organic pineapple production with a view of comparing the two production systems at various stages of production and at processing level.

The following discussion questions have been formulated to assist in the acquisition of the above information at pineapple farm.

Stage: Planting material
What is the source of planting material?
What are the various treatments for the planting material (suckers); chemicals used and reasons of treatment; probe on treatments for pests and diseases
Name some of the varieties of planting materials used in the farm
Types of suckers used
Quality control of the materials
Is there any difference in cost between organic and conventional planting materials?

Stage: Preparing the land
Preparation of soil, tillage practices probe on exactly what pesticide and fertilizers is added.
Name the types of land preparation methods employed in each of these production systems? Probe on the steps of land preparation and implements used.
What is the cost of the land preparation in both systems per Ha?
Are there any specialized considerations that you must take into consideration during the land preparation?

Stage: Planting system
Which planting systems/methods are in use in both conventional and organic systems?
What are the reasons for use?
What are the steps, timelines?

Stage: Maintaining the crop
Weed management (exactly what sort of pesticide or methods is used), implements?
What are the techniques employed in weed management?
How many times is weeding carried out in a single crop cycle?
How much pesticides/herbicides is applied per Ha?
How much active substance is applied per Ha?
Do the workers use any protection gear when applying pesticides/herbicides?
Are there any use of herbicides which ones?
What is the cost of weed control in a single crop cycle?

**Water management**

<table>
<thead>
<tr>
<th>Water management methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Stage: Soil fertility regime**

<table>
<thead>
<tr>
<th>Soil fertility management practices and methods (List types of fertilizers used and reasons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Stage: Pest and disease management**

The main interest here is to know exactly sort of pests and pesticide are used both in the conventional and organic system and also to know the potential environmental impacts that such application have.

*The most common pests – Fill in appropriate information in the table below*

<table>
<thead>
<tr>
<th>Pest – explain what sort of pesticide and how it affects the plant/fruit</th>
<th>Conventional use of chemical pesticide or method to prevent the pest</th>
<th>Organic use of organic pesticide or method to prevent the pest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Stage: Harvest**
How do you determine the maturity of the fruits?
How do you ensure uniform maturity of fruits? Probe on use of chemicals in ensuring uniform maturity.
What do you do once the fruits have been assumed mature?
What are the harvesting techniques/methods employed by the company?
List any other added activities that fresh pineapples undergo before they are finally packed and exported/sold.

**Stage: Post harvest treatment and handling describe**

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Stage: Processing**
What different processing methods are used?
What ingredients are used, probe on sugars, chemicals, preservatives.
What packaging materials are used?
How is quality control maintained?

**Stage: Marketing**
Where are the main markets?
What is the market share for different destinations?
What are the market segments?

**Future outlook**
It would be interesting to know what sort of plan the pineapple farm has for the future.
Ex. What are your plans for the future (5-10 years ahead)?
Do you have any assumption for how the market will develop for organic/conventional pineapples?
What markets will you focus on?