REPUBLIC OF KENYA

MURANG'A COUNTY ASSEMBLY
P. O. BOX 731-10200
MURANG'A

REPORT

AGRICULTURAL STUDY TRIP TO ISRAEL

10^{th} -18^{th} JUNE, 2014.

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MURANGÁ.

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1.1 PREAMBLE

Agriculture remains the mainstay and the largest contributor to Kenya's gross domestic product. It accounts for about 24% of the GDP, 74% wage employment and 50% revenue from exports. Majority of the counties in Kenya therefore engage in agrarian activities in small scale Murangá County being one of them.

With an approximate population of 942,581 consisting of 48% male and 52% female (2009 National Census Report), Murangá residents are predominantly small scale farmers with a sizable group undertaking dairy farming. The county borders Nyandarua to the west, Embu to the east, Nyeri to the north, Kiambu to the south and Machakos and Kirinyaga counties to the southeast and the northeast respectively.

Agriculture is one of the devolved functions of Government under the new constitution. The key deliverable as long as agriculture in the counties is concerned is the extension services. In this regard, educational study trips are paramount to enable informed decision making, policy formulation and adoption of new technologies especially at the county level. It is in this back drop that a group of legislatures from Murang'a County Assembly choose to have an agricultural education tour in Israel.

Why Israel?

Israel is a major exporter of fresh produce and a world-leader in agricultural technologies despite the fact that the geography of Israel is not naturally conducive for agriculture. Against major pitfalls owing to lack of water and unfriendly climatic conditions due to the fact that over 50% of the land cover is desert, agriculture in Israel accounts for 95% of its own food requirements, supplementing this with imports of grain, oilseeds, meat, coffee, cocoa and sugar.

With an approximate area of 27,000 km² which includes 445 km² of inland water bodies. Israel is located in the Middle East, bordering the Mediterranean Sea for a length of 273 kilometres (168 miles). In the south and southwest, it borders the Gulf of Aqaba and the Sinai Peninsula. To the east, it shares a 238 kilometre (147-mile) borderline with the Hashemite Kingdom of Jordan and 307 kilometres (189 miles) with the Palestinian Autonomous Area on the western shore of the Jordan river. In the north, Israel shares 79 kilometres (49 miles) of borders with Lebanon, and with Syria for 76 kilometres (47 miles) on the Golan Heights. It currently has an approximate population of 8 million persons.

Most of Israel's agriculture is based on cooperative principles that evolved in the early twentieth century. There are two unique forms of agricultural settlements; the ***kibbutz,*** a collective community in which the means of production are communally owned and each member's work benefits all. ***(Each one gives as much as he can and gets as much as he needs)***; and the **moshav,** a farming village where each family maintains its own household and works its own land, whereas purchasing and marketing are conducted co-operatively. Both communities have for a long time provided a means not only to realise the dream of the pioneers to have rural communities based on social equity, co-operation and mutual aid but also to gain agricultural output in the most productive way possible.

Today, 76% of the country's fresh produce as well as processed food products are carried out in the between kibbutzim and moshavim systems. Land is owned by the government and given to residents on leasehold basis of 99 years.

2.1. Executive Summary

Israel is a major exporter of fresh produce and a world-leader in agricultural technologies despite the fact that the geography of Israel is not naturally conducive for agriculture. Against major pitfalls owing to lack of water and unfriendly climatic conditions due to the fact that over 50% of the land cover is desert, agriculture in Israel accounts for 95% of its own food requirements, supplementing this with imports of grain, oilseeds, meat, coffee, cocoa and sugar.

Arava Research Institute centre is an agricultural research institute which spreads from the Southern end approximately 15 miles from the Dead Sea and extends North to Eliat city. The centre specialises in various projects aimed at; protecting and propagating the rare medicinal & biblical plants, solar generation systems, the methuselah project whose aim is bringing back the original date breed in terms of flavour and medicinal content, automated irrigation systems and production of Astaxanthin anti-aging compound.

The Dead Sea is the lowest point on the earth with a height of 428 metres below sea level. The mineral content at the sea is approximately 35% unlike other water masses which have 5%. This unusually high concentration of salt and minerals creates natural buoyancy which allows people float on water making it a favourite tourist attraction for fun lovers and at the same time appealing researchers in equal measure.

With the growing population, land has become a much sourced after factor of production. This has resulted to innovation of other ways of farming. The hydroponic farming involves propagation of crops on water (not on soil). The water is specially treated with minerals and nutrients to best support germination and growth all other factors remaining constant i.e warmth and oxygen.

Kibbutz Amalog is home to a herd of over 270 dairy cows. The use of new and specialised technologies enables the cows to survive the harsh climatic conditions without jeopardising milk production. This technologies include air conditioned sheds, dairy showers three times day music inclusive, computerised treatment per cow as every cow is fitted with a microchip that sends data to a central hub where specialised individualised treatment takes place.

To maintain the breeding quality of cattle in Israel, SION-Israeli Company for Artificial Insemination & Breeding Ltd is a semen producing company where Semen is collected from each bull twice a day, four days in a week cumulatively making 8 shots per bull per day. One ejaculation from an average young bull produces 3mm of sperm able to inseminate 300-400 cows.

The NAANDANJAIN Irrigation Company is a leading global producer of tailor made irrigation solutions offering a wide range of cost-effective and customised technologies across 100 countries Kenya included. In Kenya, the company has designed and implemented phase one and two of irrigation at Del-Monte Kenya limited and the third phase is on progress on 130 hectares of land.

The IGUDAN - Dan Regional Association for Environmental Infrastructure (A sewerage treatment centre) is one of the most fascinating centres in Israel. The company's key objective is to save water by effluent reuse, while improving the quality of the environment. The company converts 98% of effluent into pure drinking water currently used mainly for irrigation and for domestic use in various countries like Singapore.

Finally read about fish farming in Kibuttz.

2.2. Logistical Brief - Departure

The team (annex 1) left for Israel on June 10th, 2014 at 7: 35 am aboard Ethipoan Airlines, had a 2 hour stopover in Addis airport to later arrive at Ben Gurion airport – Tel Aviv at 3:00 am and left Tel Aviv for Kenya Via Addis Ababa on 17th arriving Nairobi on 18th at 10:30 am.

Israel Delegation led by the Deputy Speaker Hon. Moses Gachui (extreme right front row)

3.1 ARAVA INSTITUTE RESEARCH CENTRES – KIBUTZ KETURA

Arava, in literal terms means 'desolate'' or 'dry area. The institute was founded in 1996 to prepare young leaders to cooperatively solve the regions environmental challenges. It is dedicated to carry out investigation and preservation of arid lands and their natural resources. The centre spreads from the Southern end approximately 15 miles from the Dead Sea running North to Eliat city. It forms part of the Jordan valley which is an extension of the Great Rift Valley in Kenya. The research institute lies on 3000 hectares of land

Arava Research Institute specialises in various projects:-

The Middle East Medicinal Project (MEMP)

In localised terms the project is dubbed 'The village pharmacy'.

The project aims at protecting and propagating the rare medicinal and biblical plants. As a result MEMP has innovated pharmaceutical treatments for cancer and malaria while at the same time preserving and domesticating the rare species to ensure that plant material is available for research without causing harm to wild populations. One of the key success of the MEMP project is the propagation of Artemisia family where anti – malaria drugs are extracted and the Neem tree acclaimed for several medicinal uses in India and other parts of the world.

Dr. Solowey's son explaining to Members the importance of Amarula and nymph trees

The Arava Solar plant

This is a 4.95 –megawatt premier solar field in Israel managed by the Arava Solar Company. The plant is fitted with specialised solar panels that have a self-cleansing mechanism, despite their close proximity to the ground and the numerous windy seasons in the region. Originally Israel was spending lots of levies importing fossil fuels to power the country's economy. This importation came with numerous costs both environmental and societal costs associated with pollution.

After the inception of the Arava Solar Plant in 2011 after 30 years of negotiation between the government and the stake holders, the need for fossil fuels has drastically reduced.

The plant generates most energy during the day when energy use is at its pick and temperatures are high. During the night the community utilises the government supplied power at a lesser cost.


The Arava Solar Plant

The Methuselah project.

Methuselah is a date plant that the world renowned Professor, Dr. Elaine Solowey sprouted from a 2000 year old date seed. It derives its name from a biblical personality who lived longest whose name was 'Methuselah'. The seed was found during the excavations of the Masada in the mid-1960s.

Although it was deemed botanically impossible Dr. Solowey successfully germinated one of the seeds and today the plant has a permanent home in Arava Institute Research Park. The project's success has by large received world accolades and has been featured in the New York Times, the national geographic and other publications. It is believed that in the near future methuselah will be able to produce the same date variety eaten during Jesus times, having the age old original flavour and medicinal properties.

The Astaxanthin Project.

Astaxanthin is an anti- aging compound harvested from certain species of algae under high – end technological conditions. In this research institute, the algae is under fed and subjected to stressful conditions. It is in this state that the species produces *astaxanthin(an anti- aging compound).* The product is on so high demand that the community is currently satisfying only 2% of the world demand. The astaxanthin compound has a market value of between $7000 -14,000/= per kg. As a result the institute is facing out dairy farming to pave way for the Astaxanthin Project.

Dates and vegetable production

The institute also specializes in date plantation on a much larger scale and the propagation of vegetables in green houses and tunnels on a smaller scale. Dates can withstand very harsh climatic conditions characterised by very high temperatures, an average evaporation rate of 3600mm per year and an annual precipitation rate of 50mm. It takes an average of six years for the dates to produce the fruits and reach optimal production in 30 years. On average one tree is able to yield 130 to150 kgs of dates per season.

To maintain the quality of the dates being produced an off shoot is covered with a polythene bag from a closely observed mother plant. Subsequent to roots development the offshoots are transplanted to the main farm.

The centre imports agricultural soil from Jordan to support the dates propagation since bulk of the soils in Arava region are sandy soils.

Automated irrigation systems are preferred in this centre. Under this system of irrigation, each tree is attached with a micro-chip (computerized sensor) in its tissue. This enable specialised computerised treatment of the date plants by prompting the pipe nozzles on or off according to the desired water requisites of every plant. This system allows for effective irrigation by ensuring efficient use of water as only deserving plants get water.

Given that water is very scarce in Israel, the centre has drilled boreholes and preserves the waters in reservoirs. At the reservoirs the drilled waters are desalinated and a specialised polythene bag is used to preserve the waters for two main reasons;

a. To avoid siltation.
b. To protect the waters from evaporation.

A water reservoir next to a dates plantation

Water reservoir covered with a special polythene paper to halt evaporation and siltation.

4.1. The Dead Sea

The Dead Sea is the lowest point on the earth with a height of 428 metres below sea level. The mineral content at the sea is approximately 35% unlike other body mass which have only 5%. Also known as the salt sea, the Dead Sea boarders Jordan to the East, Palestine and Israel to the west. The sea spans 67 kms long and 18 kms wide with its main tributary being the Jordan River.

The sea is 377m (1,238 ft) deep, making it the deepest hyper saline lake in the world. This means the concentration of Sodium Chloride (salt at 33.7%) and other minerals supersede those of the ocean waters

meaning it cannot support life. However, this unusually high concentration creates natural buoyancy which makes people float on water making it a favourite tourist attraction for fun lovers and at the same time appealing researchers in equal measure. Scientists believe that the high mineral content, very low allergen content in the atmosphere, reduced ultraviolet solar radiation and higher atmospheric pressures around the Dead Sea have specific dermatological benefits. As a result, various cosmetics industries e.g. Ahava Cosmetic Industry have been established. The beauty products are highly marketable especially in the United Kingdom.

Other industries have also been established in the region to extract potassium, magnesium and chrome making the country one of the largest exporters of potassium in the world. Among other uses, potassium is used in fertilizers. Magnesium and Chrome are by products for the manufacture of glasses.

5.1 Hydrophonic farming at Kibbutz Yotvata

Kibbutz Yotvata lies along Aravah road approximately 40km north of the Red Sea and has a membership of approximately 310 people.

The world's population is fast growing currently projected to be over 7 billion and is projected to increase to 9.2 billion by 2050. As a result arable land and other natural resources are on the decline. It is in the back drop that new technologies like hydrophonic farming have become the fastest growing ways of farming.

The hydrophonic way of farming involves propagation of crops on water(not on soil). The water is specially treated with minerals and nutrients to best support germination and growth all other factors remaining constant i.e warmth and oxygen.

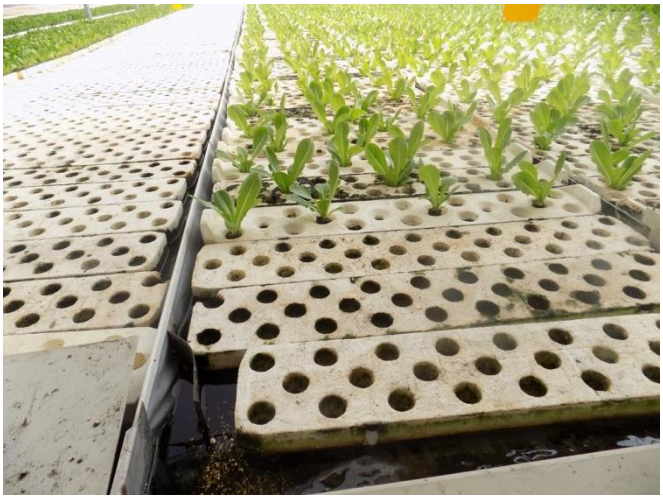
A small hydrophonic unit at Kibbuts Yotvata grows large quantities of lettuce yielding 1000 times better than a same sized area of land could produce annually. Although the initial capital in setting up a hydrophonic unit is considerably high, this mode of farming is more feasible due to its ability to feed millions of populations where water and land is scarce.

Key core benefits of hydrohonics farming are:

a. Its potentiality to offer wide variety, high yielding crops with lesser maturity durations.

b. Its biogenerative life support system. This means that as the plants grow, they absorb carbon dioxide (a greenhouse gas) and release renewed oxygen. This repetitive cycle helps keep the atmosphere clear of pollution.

A Hydroponic Nursery



Lettuce plantation through hydroponic farming

6.1 Dairy Farming in Kibbutz Amalog

Kibbutz Amalog is home to a herd of over 270 dairy cows. The use of new and specialised technologies enables the cows to survive the harsh climatic conditions without jeopardising milk production. This technologies include air conditioned sheds, dairy showers three times day music inclusive, computerised treatment per cow as every cow is fitted with a microchip that sends data to a central hub where specialised individualised treatment takes place.

The average yield per cow per day is between 38-50 litres of milk. This makes Israel one of the largest exporters of milk and milk products in the world.

The cows are fed on locally grown hay and have veterinary check-ups twice every week.

One of the cows fitted with the micro-chip

7.1 Israeli Company for Artificial Insemination & Breeding Ltd (SION)

The company has 200 bulls. Semen collection starts with bulls as young as one year old. The quantity and quality of semen improves with time for up to 8 years of age. Semen is collected from each bull twice a day, four days in a week cumulatively making 8 shots per bull per day. One ejaculation from an average young bull produces 3mm of sperm able to inseminate 300-400 cows.

A teaser bull is used to facilitate semen collection after which the semen is uniquely marked for ease of identification. Normal food colourings are used for semen identification.

After collection the semen is genomically tested to ascertain the quality of the sperms in terms of numbers, mortality rate and the progressive motion of the sperms to support fertilization. This testing takes place in the SION lab and the sperm bank.

Currently the SION lab produces large doses of semen – 8 million sperm cells per straw. The company has employed 36 insemination technicians; the 900 dairy farms are divided into 30 insemination districts, the remaining 6 technicians work as substitutes.

Each year, approximately 350,000 inseminations are performed in Israel providing 95% of all local semen in the country. SION has been providing bulls' semen to countries in Far East Asia, Central Asia and Africa. The results in these countries are extremely substantial, similar to the successes witnessed in Israel, in terms of milk production and improved genetic qualities. The bulls are vaccinated annually and they have to undergo health check-up once a year.

7.2 Bull Selection

Most farms in Israel are computerized this means data entry from the farms is done on a daily hard book. An analysis of the results from the books identifies the best dairy cows in the country.

Every year they choose 300 cows from the farms across the country and inform the owners their interest to serve them with the semen they have imported. (Semen is imported to avoid in breeding). Upon the farmers consent, they inseminate the cow and if it produces a bull they buy it from the farmer for semen collection on the contrast a heifer birth is placed under close observation. Most young bulls are proven based on subsequent daughter production records. Genetic evaluations are performed bi- annually.

8.1 Irrigation –Kibbutz Naan

Kibbutz Naan is a partly privatized Kibbutz in central Israel near Rehovot. Therein lies the NAANDANJAIN Irrigation Company.

The company is a leading global producer of tailor made irrigation solutions offering a wide range of cost-effective and customised technologies across 100 countries Kenya included.

The company has an extensive product range including comprehensive irrigation climate-control technologies for green houses and nurseries, open fields, Orchards and plantations, residential and landscape areas and industry. The technologies include a wide range of integrated round regular and pressure compensated drip line systems.

Their product range include:-

- Thin and medium walled drip-lines and tapes.
- Micro sprinklers for under tree irrigation, climate control and spraying.
- Diverse metal and plastic agricultural sprinklers.
- A wide range of control filtration solutions.
- End to end agricultural products (Designs of irrigation systems).

In kenya the company have designed and implemented phase one and two of irrigation at Del-Monte Kenya limited and the third phase is on progress on 130 hectares of land. They have also implemented similar projects in Nigeria, Benin, Ghana, Eritrea, and Ivory Coast.

8.2 Some irrigation methods

Irrigation is the controlled application of water for agricultural purposes through manmade systems to supply water requirements not satisfied by rainfall. Crop irrigation is vital throughout the world in order to provide the world's ever-growing populations with enough food. Many different irrigation methods are used worldwide, including:

- Centre-Pivot: Automated sprinkler irrigation achieved by automatically rotating the sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles, as a radius from the centre of the field to be irrigated. Water is delivered to the centre or pivot point of the system. The pipe is supported above the crop by towers at fixed spacing's and propelled by pneumatic, mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water is applied at a uniform rate by progressive increase of nozzle size from the pivot to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long and irrigate about a 130-acre circular area.
- Drip: A planned irrigation system in which water is applied directly to the Root Zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure with the applicators being placed either on or below the surface of the ground.
- Flood: The application of irrigation water where the entire surface of the soil is covered by ponded water.
- Furrow: A partial surface flooding method of irrigation normally used with clean-tilled crops where water is applied in furrows or rows of sufficient capacity to contain the designed irrigation system.
- Gravity: Irrigation in which the water is not pumped but flows and is distributed by gravity.

- Rotation: A system by which irrigators receive an allotted quantity of water, not a continuous rate, but at stated intervals.
- Sprinkler: A planned irrigation system in which water is applied by means of perforated pipes or nozzles operated under pressure so as to form a spray pattern.
- Sub-irrigation: Applying irrigation water below the ground surface either by raising the water table within or near the root zone or by using a buried perforated or porous pipe system that discharges directly into the root zone.
- Traveling Gun: Sprinkler irrigation system consisting of a single large nozzle that rotates and is self-propelled. The name refers to the fact that the base is on wheels and can be moved by the irrigator or affixed to a guide wire.
- Supplemental: Irrigation to ensure increased crop production in areas where rainfall normally supplies most of the moisture needed.
- Surface: Irrigation where the soil surface is used as a conduit, as in furrow and border irrigation as opposed to sprinkler irrigation or sub-irrigation.

Below are pictures of various irrigation methods

9.1 The IGUDAN - Dan Regional Association for Environmental Infrastructure (A sewerage treatment centre)

This is one of the most fascinating centres in Israel. It was established in 1955 by a merger of the seven largest water authorities in the Dan Metropolitan Area; Tel aviv, Holon, Bat yam, Givatayim, Ramat Gan, Bnei Brak and Petah Tikvah. The key goal was to save water by effluent reuse, while improving the quality of the environment. In order to achieve this Igudan founded the Shafdan wastewater treatment plant one of largest wastewater treatment plants in the world.

Built on a firm founded reality of the importance of wastewater recycling in Israel, the Shafdan currently treats all the waste water from the Dan area thereby providing 70% of irrigation water in the Negev region(main agricultural region in Israel). Although the process is long and complex, eventually millions cubic litres of treated effluent are conveyed to the Negev fields every year. In order to make waste water suitable for irrigation, the effluent undergoes biological processes, organic decomposition, decomposition of chemical compounds and oxidation. These are natural supportive processes that require minimal manpower support. As a result this fascinating plant has employed on 47 persons to man the whole region.

It's one of its kind in the whole world currently under case study by the Harvard University

9.2 Waste Water Conveyance

The wastewater collection infrastructure is comprised of four major pipes with diameters ranging from 120-300cm and a total length of approximately 120 kms. These carrier pipes run 30 metres deep through

the Dan metropolitan area. As the normal city life goes on in this busy metropolis, an equal hive of activity is taking place underground.

To enhance gravity there are 7 pumping stations that pump the waste waters at the rate of up to 14 000 cubic metres per hour into the Shafdan treatment centre.

9.3 Stages of wastewater treatment

The wastewater flows through several treatment stages that last approximately one year to complete.

9.3.1 Preliminary Treatment

Every day, 370,000 cubic meters of wastewater flow to the Shafdan. The wastewater is screened and degritted at the preliminary treatment facility. Three stages of bar screens on various sizes (100, 20 and 6mm) remove the debris, and eight vortex grit separators separate out sand and grit.

9.3.2 Primary Clarifiers

The wastewater flows through a system of 20 primary sedimentation basins, 45 meters Long and 12 meters wide each, where a high percentage of the suspended solids settles at the bottom of the clarifier. The settled sludge will then be transferred from treatment by anaerobic digestion.

9.3.3 Biological Reactors

The biological processes of carbon oxidation, nitrification and de-nitrification take place in 4 biological reactors, each with a 55,000 cubic meters volume. The reactors work at constant flow and are fully mixed. Each reactor is equipped with 36 mechanical surface aerators. The hydraulic retention time of each batch of wastewater in the biological reactor is about 16 hours.

9.3.4 Secondary Clarifiers

The liquid-solids separation of the mixed liquor from the biological reactors takes place in 12 secondary clarifiers, 7,500cubic meters volume each.

The treated effluent is conveyed to tertiary treatment and the secondary sludge is sent to the sludge thickening facility.

9.3.5 Sludge Thickening Facility

The secondary sludge undergoes a thickening process in six gravity belt thickeners,180 cubic meters per hour capacity each .During this stage the solids concentration will rise up to 5% as dry solids.

9.3.6 N-Viro Fertilizer Facility

Approximately 15% of the sludge, equal to about 150 tons of sludge per day, is mixed together with coal ash and lime to create about 70,000 tons of agricultural fertilizer per year. This organic fertilizer is given to farmers for free.

9.3.7 Anaerobic Digesters

The primary sludge from the primary clarifiers is mixed with the thickened waste secondary sludge in order to get a homogeneous sludge mixture. This mixed sludge is conveyed into one of the eight anaerobic digesters, each capable of holding a volume of 13,200 cubic meters, to undergo thermophilic anaerobic digestion for 14 to16 days. This process produces a class "A" bio solids. The methane gas that released during anaerobic digestion is used for energy production in a combined heat and power [CHP] generating facility.

9.3.8. The Dewatering Facility

Five centrifuges, 80 cubic meters per hour capacity each, dewater the digested sludge. These machines rotate at speed of 3,000 revolutions per minute, and increase the solids concentration to about 25% (as dry solids).

9.3.9 Sludge Loading Facility

The treated sludge is transferred to 4 storage silos, with a total volume of 2,400 cubic meters. This allows the regulated loading of the sludge into the trucks, conveying it to the agricultural areas for use as fertilizer.

9.3.10 Key Facts about the Sewerage Treatment

- Oils filtered from the sewerage are taken to factory to be recycled and produce bio diesels.
- Recovered sludge from the treatment process is used as fertilizer.

- Secondary affluent is re-filtered using sand, a process that takes 400 days, to come up with very clean water that can be used for drinking. The re-filtered water is further oxygenated them pumped for shower and taps for drinking especially in Singapore. NB/(Israel has not yet used reclaimed water for drinking)
- Cost of running up the sewer treatment plant is not expensive as it uses biological factors to purify the water hence no expenses incurred to purchase chemicals. But the cost of setting up the plant is huge.
- Methane gas produced by bacteria is used to produce electricity that is running the sewer treatment plant.
- One cubic metre of sewer is translated into 98.8% water.

10.1 Fish Farming – Kibbutz Dafna

Kibbutz Dafna is in the upper part of Galiiee in northern Israel.

It was the very first kibbutz to be established in Israel in 1910. It has been practicing strict kibutz system until the modification of the system in 2000.

The farm rares fish, it imports fish eggs from USA six times a year. The fish grows up to half a kilo and at such weight it is ready for the market. They have modified streams to enhance maturity of the fish. Fish are injected with iodine at a net weight of 70 gms. The fish ponds have a net fence to protect the fish from direct sunlight and from the predators. The market comprises both local and export. It is estimated the farm has around 15000 fish.

Kibbutz dafna exercises other forms of farming like raring cows, planting maize but they emphasize more on fish farming.

A net fenced fish pond

Water aeration to enhance oxygen supply

11.0 RECOMMENDATIONS

Members came up with the following recommendations.

1. Water harvesting- the County Government to ensure supply of piped water for both domestic and irrigation purposes.
2. Cooperative Development in the County should be enhanced.
3. Stoppage of further subdivision of land to small un-economic units.
4. Private public partnership in irrigation through the Built Operate Transfer System (BOT). This system allows a private developer to install irrigation units in the county and charge the locals a subsidised fee for the service for a specified period whereas the rest of the cost is undertaken by the County Government.
5. The County Government to conduct civic education to the people of murang'a in order to create awareness and enhance a change of mind-set as far as development issues are concerned.
6. Leaders to be committed and patriotic.
7. County Government to regulate law and order in conserving the environment.
8. Zero tolerance of corruption at County Level.
9. The County Government to develop solar power farms in the lower parts of Murang'a for example in kambiti ward.
10. Embrace the use of advanced and modern technology in our farming systems especially in drip irrigation, hydroponics, sewage treatment plant and computerized revenue collection.
11. Improve the cultural sites within Murang'a County by identifying, protecting and upgrading them to attract tourists in our county

12.0 REFERENCES

1. **The Arava Institute for Environmental Studies**

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3. **NAANDANJAIN IRRIGATION COMPANY**

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4. **Igudan(DAN REGIONAL ASSOCIATION FOR ENVIROMENTAL INFRASTRUCTURE)**
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ANNEX 1 Map of Israel

Annex 2 Map of Murang'a County