Semi Industrial Solar Dryer

Construction and Utilization Manual

Guidelines for Technicians and Food Processors

TATEDO
P.O.BOX 32194,
DAR ES SALAAM,TANZANIA.
TEL: +255 22 2700438,
FAX: +255 22 2774400,
Email: energy@tatedo.org
Website: www.tatedo.org

Contents

List of Abbreviations

CHS; Circular Hollow Section

CM; Centimetres

M 2; Squaremeters

MM; Millimetres

PCS; Pieces

RM; Running Meters

SEDC; Sustainable Energy Development Centre.

SEECO; Sustainable Energy Entreprises Company

SHS; Square Hollow Section

SISD; Semi-Industrial Solar Dryer

TADEDO ; Tanzania traditional Energy Development and Enviroment Organization.

1.0 Background

Traditional application of solar drying of products is the method used to expose products directly to sun rays,left to dry to certain grade of humidity acceptable for preservation.This traditional method presents some hindering climatical factors whereby the products may be destroyed by rain,dust and wind.Also the possibility of being consumed by animals and insects,not to leave contamination risks and poor quality of the final dryed products.Also the method is only acceptable to determine type of products or when doesn't exist alternative method.The elimination of these problems is achieved by applying equipments,processes and techniques which together have received the name technical solar dryer (semi industrial solar dryer)

The semi industrial solar dryer was developed in Bolivia far back approximately about 15 years ago with a group of profesionals working on project to develop solar energy at La Universidad Major de San Simon.Apart from developing the physical model of solar dryer the intension also was to find solutions to day to day problems which were being presented by producers of food products from rural areas.

The development wasn't an easy task to the University because it was considered more academic but from the point of benefits concrete answers were extracted and theory was put into practice were direct benefits were demonstrated to the users of the technology.In this form decision was made to develop test projects,application and diffusion of the technology,introducing areas of products to be dryed,economical evaluation and market investgations.

The semi industrial solar dryer was introduced to Tanzania as part of technology transfer from Bolivia through TATEDO in colaboration with Energetica Industry from Bolivia.The implementation took place in two phases whereby phase one was facilitated by experts from Bolivia consisting of training on construction and utilization of solar dryers where an introductory training and practical sessions on processing various fruits was conducted in Sanya Juu-West Kilimanjaro and design layout drawings were provided.

Phase two of the project were conducted at Sustainable Energy Development Centre (SEDC), a TaTEDO training ,consultancy and research centre.This phase consists of hands on training on construction of semi industrial solar dryer to pilot the technonolgy in Tanzanian environment.

1.1Manual content and layout

The purpose of this manual is to serve as a directive to solar drying stakeholders on construction and utilization of semi-industrial solar dryer.

The manual is presented in the following pattern/flow;

1) Concepts and definitions
2) Design of semi-industril solar dryer
3) Construction of SISD
4) Utilization of solar dryer
5) Quality assuarrance
6) Cost analysis

2.0 Concepts and definitions

To overcome the problems encountered on application of traditional methods on solar drying,technical solar dryers are applied which we can say is a modification of traditional

solar drying.The dryer is a kind of a “Green House” whereby the products to be dried are placed inside on trays.The average temperature inside the dryer can reach up 45 degree of centigrades of which can reduce relative humidity accelerating drying time.

The function of the technical solar is one where air is heated by proportionate solar energy and the effect of “Green House”.At a determined temperature the warm air circulates through the products causing dehydration of the same.

2.1 Advantages;

(a) The value of dried products is increased interms of quality,opening possibilities of higher market prices.
(b) Hygenic conditions are improved.
(c) Convectional combustions are saved,the dryer needs nothing more than solar radiation of which her costs are practically free.
(d) Improves the storage conditions and reduces waste of products after harvest
(e) Time saving; Duration of drying with technical solar dryer is much less compared with traditional drying and also less space required.

2.2 Disadvantages

The technical solar dryer is not a solution for all dehydration processes.Some certain limitation are taken into consideration;

(a) The SISD functions only when there is enough sun.Areas where the humidity is too high is not applicable,unless other conventional methods are applied.
(b) Initial costs to acquire one SISD may need high costs of investment
(c) Selective usage;For some products the difference between production cost and market prices is so small than the usage of SISD is discouraged.

3.0 Design of Semi Industrial Solar Dryers (SISD)

3.1 SISD;main parts and accesories

The solar dryer is constructed having the following main parts/items

I. Metal structure which comprises the drying chambers constructed from metallic square hollow sections.
II. Transparent plastic cover (visqueen sheet),thickness 250 microns
III. Trays assembled with green plastic wire mesh where the products to be dried are placed.
IV. Trolleys are supplied to transport trays during drying process also can save as part of drying chambers.

3.2 Basic parameters of SISD

Based on the original drawings supplied from bolivia basic parameteres were taken into account on adaptation of the technology transfer.

3.2.1 Dimensions

The overall dimensions of the dryer are 7.23mx 4.2m(length –width) (See elevation 1 of appendix 6)

3.2.2Characteristics

The elevations are as follows;

- Lateral sides are 1.7m high above the floor (elevation II0
- The centre part has two dimensions 2.47m and 2.15m high above the floor,the difference between the heights gives room for ventilation and air outlets(see elevation III of appendix 5)

The total number of trays is 28,24 trays on the sides and 4 trays on special trolleys also are made to facilitate transportation of trays on process of drying.

3.2.3 Drying capacity

The drying area of each level of trays is 16m giving total of 32m of drying area.If we load our products at 8kg/m total we have 256kg to be dryed per batch.

4.0 Construction of SISD

As mentioned on chapter two the construction is based on the drawings supplied by Energetica . The dryer is consructed in form of modules (drying chambers) which are separated by identical structures as shown on elevation appendix 4.However, in order to suit the Tanzanian's condition on the dryingg processes,some few chanes were adapted to the original design such as; to include one module(chamber)for isolaton of insects when entering the dryer,the use of trolleys as part of drying chambers,changing size of trays without altering the capacity.

4.1 Procedures for Construction of SISD

As mentioned on previous chapters the main structure is constructed of steel (Square Hollow Section) of dimensions 25x25x1.5 mm.

This material is prepared by cutting to required dimensions as per drawings.Special care must be taken on cutting process to minimize waste of construction material.

As dryer is constructed in form of modules some other items are also prepared for joining the modules on assembly.These items are listed on appendix 1 of bill of materials and cost analysis.

Table 1: List of elements required for construction of SISD structure

Element	Dimension (mm)	Number of Elements	Remarks
Lateral members	3995	5	Left side
Lateral members	3710	5	Right side
Centre members	2105	5	Left side
Centre members	1954	5	Right side
Joining cross members	1250	20	Front, Middle and Rear Structure
Door elements	1910	8	For two doors
Door elements	820	8	For two doors
Front upper cross member	1700	2	Two doors
Rear cross member	1700	3	Rear structure

4.1.1 Preparation of element members

The main structure are prepared by bending and welding the cross members as indicated on drawings. Lateral members, dimension 3995mm and 3710mm are bent to form the inclination of the roof of the dryer. The inclination can be achieved by measuring required dimension on the sides (1550 mm above the floor), then setting the center members 2105mm and 1954mm length respectively.

Cross members (1250mm) are then set and welded to both structures accordingly. These activities from the sub-assemblies of five structures, two of them with doors to be joined on installation process. This process can take about two days to be completed.

4.1.2 Cutting, drilling and welding of Angle brackets.

a) Cutting
   - 52 pieces of longitudinal members 1776mm
b) Cut angle bracket to size 25mm width, for joining structures (64 pcs)
c) Drilling of fastening holes
   - Diameter 8mm on angle brackets and 5mm on lateral members
d) Weld angle brackets together with longitudinal members (1776mm)

4.1.3 Primer paint

All prepared elements and sub assemblies are coated with gray primer left to dry at least for one day. This is performed to preserve the metal structure.

4.1.4 Installation of sub-assemblies of metal structure

The sub assemblies are fixed on prior built brick wall on compacted floor at equal distances forming drying chambers. The installation Elements required are outlined below:-

i. Assembled sub-structures
ii. Base plates 100x75mm, thickness 4mm
iii. Rawl bolts 8mm diameter – 12NOS
iv. Longitudinal members (25 x 25 x 1.5mm – L = 1776)
v. Bolts & Nuts M8 x 40mm

The Installation of sub-assemblies of metal structure involved activities such as:-

i. Welding base plates on structure legs
ii. Drilling base plates, holes 8mm diameter
iii. Fixing raw bolts at specified areas following the dimension of the solar dryer
iv. Assembling Longitudinal members (L = 1776mm) joining the dryer five structures by bolts & nuts prior fixed with raw bolts

Figure 1: Activities for construction of Semi Industrial Solar Dryer (SISD)

4.1.1 Setting of Solar Dryer Structures

The main structures are set according to dimensions by welding the indicated parts.Joining elements e.g;SHS and angle brackets are welded together to the required dimensions.Drilling of fastening holes takes place parallel to the other activities according to engineers instructions.

4.1.2 Construction of Trays

All the elements used for construction of trays are outsourced and prepared.The items involved are:-

i. Square hollow section 25 x 25 x 1.5 mm
ii. Flat bars 25 x 3mm
iii. Pop Rivets 5mm diameter
iv. Green plastic wire mesh

The procedure/activities followed are:-

i. Square hollow sections welded together to form tray structure frames into dimension of 1300mm x 880mm
ii. Cleaning frame and coat with gray primer
iii. Cutting flat bars to dimensions
iv. Drilling fasten holes 5mm diameter on frames and flats
v. Painting with Aluminium coating on frames
vi. Fixing green wire mesh, fastening and tightening with rivets and flat bar

As for other items mentioned above on preparing plastic wire mesh,study must be conducted regarding dimensions of the dryer to avoid waste of wire mesh.


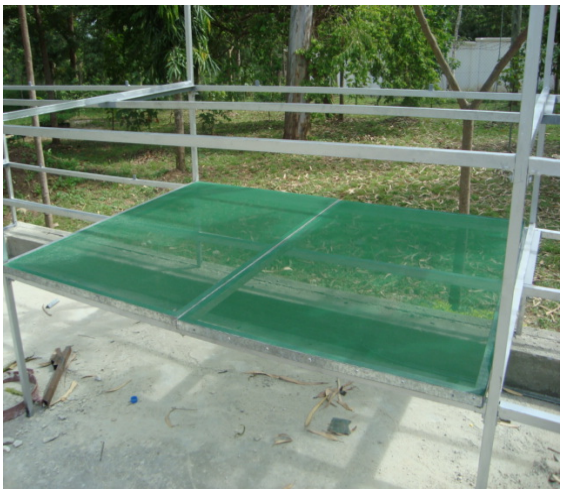

Figure 2: Fabrication of trays including cutting of plastic green wire mesh

4.1.3 Construction of trolleys

The dryer is supplied with two trolleys.They are constructed using the following elements,

- Circular hollow section diameter 25 mm
- Square hollow section 25x25x1.5 mm
- Castor wheels diameter 5”
- Angle section 25x 25 x3 mm
- Bolts and nuts M8
- Fixing plates 100mm x 100mm – thickness 4mm

Procedure/Activities

i. Bend circular hollow sections to required dimensions
ii. Weld angle sections/square hollow sections

iii. Weld fixing plates
iv. Assemble castor wheels
v. Primer painting
vi. Finishing with Aluminium paint

NOTE: The Overall dimensions of the trolleys are designed to accommodate the trays which can be utilized also as drying chambers on the remaining levels.

The overall dimensions of the trolleys conform to the size of trays.These trolleys can transport five trays at a time and after arranging the trays on the drying chambers four of the trays are left with products to be dryed on the trolleys.

Figure 3: Trolleys inside the dryer utilized for transport of the products

4.2 Installation of SISD

The installation comprises of five structures forming parts of the main structure well fixed with rawl bolts 8mm on a brick wall prior constructed on a well compacted floor of size 8mx6m.

The structures are set at equal distance joined together with square tubing 25x 25mm fixed with bolts and nuts .The required dimensions of the drying chambers to accomodate the already assembled trays,in this case are at a distance of 1776mm (see structural appendix 3).

4.2.1 Painting Process

The painting process is done on some parts before the installation procedure.This is done on parts such as trays before assembly of green wire mesh.Before final painting all parts are coated with gray primer and finally with aluminium paint.

4.2.2 Fixing Visqueen Sheet and Plastic Mesh on Air Inlet and Outlet Windows

The assembly of visqueen sheet is fixed together with thermal isolation rubber well tighten with galvanized flat bars using rivets or screws.The role of the thermal insulation rubber is to protect the visqueen sheet from the temperature arising from the square hollow sections and fixing plates.The visqueen sheet is well stabilized to have good resistance on ultraviolet rays which have the tendency to destroy the nutients in the food.The sheet also is used to increase/raise the ambient temperature inside the dryer.

Assembly of Visqueen Sheet

The elements required for the assembly of the visqueen sheet are such that:-
i. Visqueen sheet 250 microns thickness
ii. Flat bars 25 x 3mm
iii.Screws / Pop rivets 5mm diameter
iV.Thermal insulator rubber

The activities involved in the process are:-

i. Preparation of visqueen sheet by cutting, measuring to required dimensions to prevent material waste (overall width of visqueen sheet 6.8metres)
ii. Preparation of thermal insulator rubber stripes by cutting to size (25x3mm)-L=1500mm.
iii. Covering main structure with visqueen sheet.
iv. Assembling by means of screws/pop rivets the visqueen sheet well stabilized to resist ultraviolet rays.
v. Assembling of the lower vent green plastic mesh.

The assembly of visqueen sheet on this case particular took about 8 days.

Figure 4:Technicians fixing visqueen sheet on the structure of solar dryer

4.2.3 Air Inlet Vents

The air vents/windows are provided in order to allow entrance of fresh air inside the dryer thus allowing the humidity to escape through the upper air outlets.This will allow appropriate air circulation inside the dryer which is necessary for proper drying.The air inlet vent should be well covered with green plastic mesh tightened with flat bars and rivets.This process must be handled with maximum care against the use of excessive force which might let the riveting machine to torn the visqueen sheet.The elements of the air inlet vent are Green plastic mesh, flat bars and screws 5mm diameter. Activities involved are as outlined below:-

i. Cutting of plastic mesh according to size :Upper air outlet about 400mm width, lower air inlet 200mm width. Total length required: 7.23m upper vent, 14.46m lower vent
ii. Fixing upper vent wire mesh on main structure using screws 5mm diameter with tightening flat bars.

Figure 6: Technicians fixing the air inlet vent of green wire mesh

5.0 Utilization of Solar Dryers

Food processing may be defined as a process, in which a raw material is biologically, chemically or physically treated and transformed into a slight or totally different type of food. Food processing together with food preservation aims to prolong the shelf life of agricultural products, control the seasonal variation of food supply, stabilise the marketing of agricultural products, improve the food quality and contribute to the national economy through foreign exchange earnings from the export of processed food and increase job opportunities.

The process of drying consists of the removal of moisture from food by heat. It is a process of taking out large part of water content in the product in order to reduce considerably the reactions that lead to the product's deterioration.

It is a technique used to reduce crop spoilage through microbiological actions e.g. rotting which is caused by the growth of bacteria and fungi. When moisture content is below a certain level, those micro-organisms are killed. As a result, drying stops microorganism growth. When fruits come into contact with water again, the micro-organisms still present are quickly reactivated. After the food has been cleaned, peeled (fruit or vegetables) and further prepared, it spreads out over a tray(s) (that are made of mesh fixed on a metallic frame), which is then placed in the dryer.

Fresh products (fruits and vegetables) have moisture contents of about 70 – 95%. At these values, the product is subject to deteriorate very quickly as microorganisms are very active. Solar drying can remove moisture contents to about 5 – 25%. At these levels, depending on the type of the product - the products are free from micro organism reactions or activities.

6.0 Factors Affecting Solar Drying

- **Nature of the Material –** different materials possess different properties due to variations in shape, moisture equilibrium or the mechanism of flow of moisture through the material resulting in different drying rates, even under the same conditions.

- **Layer Depth of the Drying Material –** the thinner the material layer, the faster the drying becomes. This facilitates entrance of the air and solar radiation to most of the materials.
- **Solar Radiation Intensity –** higher solar radiation intensity reduces the drying time, whereas low solar radiation intensity leads to prolonged drying process
- **Air Velocity –** a relatively high velocity stream passing over the surface, reduces the thickness of moisture layer and increases both heat transfer and evaporation rate.
- **Ambient Temperature and Humidity –** highest drying rates will be obtained at the maximum practicable air temperature compatible to the tolerance of the material to be dried, coupled with low relative humidity, which may be increasing by preheating the air prior to the drying process.
- **Collector Orientation –** a surface will receive the maximum energy if points directly toward the sun (i.e. is perpendicular to the sun), dryer should be placed so that it faces North in the Southern hemisphere (or vice versa for the Northern hemisphere) and is slanted at an angle so that upper surface is pointed directly toward the sun.

6.1 Processing Food and Hygiene

The following factors should be observed when processing food using solar drying technology

- The processor (personnel) cleanliness
- The processing place (room) cleanliness
- The equipment and tools cleanliness
- General processing cleanliness

Note:

On preparing fruits and vegetables to be dried, one must consider:-

- Selection of quality fruits/ vegetables
- Washing
- Peeling
- Cutting or slicing into small pieces

6.1.2 Processor Cleanliness

The person involved in the food processing for solar drying is supposed to wear neat and clean clothes including the following:

- Should cover his/her hair by wearing a cap or just cover hair using a piece of cloth
- Apron, pair of gloves and coat are supposed to be washed everyday after use
- Any fresh wound or skin disease should be cleaned and dressed properly
- Should wash his/her hands with warm water soaked with soap before and after processing product
- Toilet and its utensils should be kept very clean all the time
- Do not apply perfume and any other cosmetics, as their smell may spoil the smell of the product processed
- Do not wear earrings, necklaces and rings, as they may drop into the processed product
- Any animal is not allowed to enter or even being close to the product processing room
- The processing place (room) should not be used for sleeping
- It is not allowed to smoke, eat or drink in the processing room
- If somebody is suffering from stomach problems, -vomiting or diarrhoea; he/she is not allowed to process any product to be dried
- You should have special place far from the processing place that can be used for eating food and drinking

- Whenever handkerchiefs, etc have been used, he/she should wash hands before proceeding with product processing work

6.1.2. Processing Place (home, industry or workshop) cleanliness

- The processing room should be of good standard, i.e. floor, ceiling, windows and doors should be in good order - not allowing dust into the processed products
- The place should not be accessible to birds, chicken, insects and any other animals
- The processing room should have good ventilation
- Water used for washing processed product should be clean and safe for human consumption
- There should be a room used by your workers to exchange their clothes and for keeping their belongings
- Dust should not be allowed to enter the processing room
- Disinfectant should be applied to clean floor of the processing room

6.1.3. Equipment and Tools

- All equipment and tools used for processing products should be kept clean. Rusted tools must never be used for processing product as they may contaminate the product being processed
- Store equipment and tools at clean and safe place
- Never allow dust to come in contact with the equipment and tools used for processing products
- Make sure that no part of any equipment or tool is mixed with the processed product, e.g. if glass thermometer is used, make sure that it is not cracked

6.1.4. General Processing

- Make sure that the products to be processed are clean and have the required quality, e.g. fruits should not be rotten
- Store products which have not yet been processed in clean and safe places
- Use the proper equipment and tools for processing products
- Strong chemicals and poisonous products should be kept away from the processing room
- Store in separate places, processed product and one to be processed
- Never use soaps and detergents with strong smell, as they may influence their smell to the products being processed.
- To wash processed product, use water mixed with chlorine to kill any bacteria present; this way chlorine cannot remain in the processed product.

Table 1: Processing Procedures for Different Products

Product	Preparation	Size of the product to be dried [mm]	Humidity (% water content) Initial (final)	Drying time [days]
Mangoes	Wash, peel and slice into small pieces on its width	4-5		3-4
Ripe banana	Wash, peel and slice into small pieces either on its width or	4-5	80 (15)	3-4
	On its length	8-10	80 (15)	5-7
Pineapple	Wash, peel, remove the central hard part and slice into small pieces on its width	6-8		3-4
Carrot	Wash, peel and either slice into small pieces on its width or grate	4-6		1-3
Vegetables	Wash and cut into small pieces, you can as well blanch to maintain taste and colour			1-3
Egg plant	Wash and cut into small pieces	10-12		3-4
Onions	Peel and cut into small pieces on its width or length		80 (4)	3-4
Tangawizi	Wash, peel and cut into small pieces	5-10		3-4
Binzari	Wash, peel and cut into small pieces	4-8		4-6
Fish	Wash and you can as well apply salt			4-5
Tomato	Wash and slice into small pieces on its width	6-8		4-5
Mushroom	Wash and spread on drying tray			3-4
Unripe Banana	Wash, peel and slice into small pieces on its length	10-15		3-4
Hibiscus	Peel, wash and spread on the drying tray			2-4
Giligilani	Sort, wash and spread on the drying tray			1-3
Potatoes	Peel, slice into small pieces and wash using warm water to kill enzymes	10-15	75 (13)	3-4

Note:
It is recommended to load dryers in the morning, as heat in the dryer will be low at that time, product will be dried gradually which is necessary for better quality of the final dried product. It is also recommended to unload dryers in the afternoon to have dried product with less or intended moisture contents, when the dryer is unloaded in the evening there is possibility that the hygroscopic nature of the product at that time to absorb moisture from the surroundings which will affect the quality of the dried product.

7.0 Quality Assuarance

Results of the chemical analysis conducted by independent food technologies in Tanzania and overseas, show that the solar dried products yield superior quality products as compared to the traditional sun drying. This means that the dried fruits and vegetables can be sold at both local and international markets, where the demand for high quality solar dried products is higher.

In semi industrial solar dryer model,quality assuarance of the products produced is governed by the shape of the dryer which has large space inside the drying chamber. This facililitates an easy circulation of air thus promote appropriate drying of fresh product.Proper solar drying techniques facilitates production of quality products which retains pleasant color,neat appearance and fine taste.

8.0 Cost analysis for a Semi Industrial Solar Dryer (SISD)

The dryer construction costs depend on many factors which include size of the dryer required,type of materials used,location where it is made from the source of raw materilas like metal tubing,UV resistance plastics,quality desired etc.In most cases construction costs constitute raw materials costs up to 80% and the remaining 20% is labour costs.In most cases maintenance cost is not part of construction deal and comes as separate entity when the need arises.However, if the dryer is managed properly, it can not exceed 5% of the dryer construction cost per annum.

In a well-managed solar drying business, payback period for the three mentioned dryer sizes is between 6 – 24 months depending on the production volume, market and cost of raw materials. Depending on handling, the dryer UV resistant plastic (visqueen), could last more than two years before changing it. The framework (metallic structure) could live even longer time if treated with anti-corrosive materials such as red oxide and yellow primer.

Appendix 2 is a list of prices for materials in the bill of quantitities.The total cost of the material is amounting to 2,679,300.00 Tsh based on actual market prices.(Two million six hundred seventy nine thousand and three hundred Tanzanian shillings).The costs for establishment of foundation floor and labour charges are not considered at this juncture.

9.O Conclusion

The semi-industrial solar dryer is an ideal instrument for small scale entreprenuership to promote business on dried products mainly fruits and vegetables.On buildings this dryer some investment costs must be enhanced on the usage of the dryer in order to recover the same also to develop new markets of dried products for internal and externa use.

10.0 Recommendations

This dryer is the first of its kind regarding volume and size.The method used on joining the main structure is one which can be detached if necessary on maintenance purposes.However, dryers can be built with metallic structure permanently joined by welding methods so as to minimize construction time frame and other constraints such as extra duties.

10.0 Appendicies

Appendix 2: Materials for Food Processing and Solar Drying Of Fruits and Vegetables

Description of Item(s)	Units	Qty	Unit Price	Amount (Currency(Tshs, USD, EURO, etc))
Tables	pc			
Washing containers (stainless steel or plastic)	pc			
Bowl-shaped strainer (stainless steel or plastic)	pc			
Jugs with graduated measurements (stainless steel or plastic)	pc			

Urns	pc			
Knives	pc			
Spoons	pc			
Agitator	pc			
Packaging bags	pc			
Adhesive tapes	unit			
large pot	pc			
Water	Liters			
JIKI - sodium hypochlorite	bottle			
Citric acid	bottle			
Sugar	kg			
Lemon	pcs			
Dish washing soap	bottle			
Hand detergents	bottle			
Paw paws	unit			
Mango	unit			
Mushrooms	kg			
Black currant or similar fruits	kg			
Cloth apron	pc			
rubber gloves	pc			
Mask	pc			
Hats/caps	pc			
Hand towels	pc			
Solar dryer	unit			
Thermometer	pc			
Weigh scale	pc			
Plastic sealant	unit			
Calculator	unit			
Computer	unit			
White board/marker pens	unit			
White board	unit			
Printer	unit			
Paper	bundle			
Note book	pc			
Pen	pc			

***Unit prices, quantity and amount will depend on situation in the market where those items or equipment will be procured.

Appendix 1: List of Materials for Construction of Semi Industrial Solar Dryer

Item	Qty	Unity	Unit Cost	Amount
Galvanized sheet 2mm	2	Pc		240,000
Visqueen sheet	20	M		400,000
Green plastic wire mesh	36	M		540,000
Square pipe 25x25x1.5mm	66	Pc		660,000
Square pipe 20x20x1.5mm	1	Pc		8,000
Angle section 25x25x3mm	9	Pc		107,000
Black pipe ¾	3	Pc		45,000

Thermal insulator rubber	3	Pc		21,000
Bolts + Nuts 8m	150	Pc		55,000
Screws 5mm	320	Pc		16,000
Rawl bolts	12	Pc		9,600
Drill Bits	15	Pc		21,000
Cutting discs	13	Pc		40,500
Grinding discs	27.5	Pc		4,500
Emery paper	4	M		39,000
Hacksaw blades	4	Pc		6,000
T bolts	6	Pc		6,000
Welding rods	8	Kg		11,000
Castor wheels	7	Pc		48,000
Gate hinges		Pc		4,800
Pop rivets		Boxes		70,000
Aluminium paint&Gray primer		Item		200,000
Standard thinner				25,000
Slow thinner	1.5			15000
Hardener				9.500
Putty	1			2,400
Painting brush	1			1,500
Brush wire	3			500
Ring	1			4,500
Fastening plate				7,000
Pipe bending		Item		8,000
Cutting flat bars		Item		53,000
Transport		Item		
Loading + Off loading		item		
Total (Tshs)				**2,679,300**