appendix

hydroponic crops

Abbreviated list
[Cox, 2010]

Berries
abbreviated list

Blueberry, hydrotaste.com
Cranberry, Lynette Morgan & suntec.co.nz
Raspberry, www.reeis.usda.gov
Strawberry, sunsetproduce.com

Bush Vegetables
abbreviated list

Tomato, eurofresh.com, villagefarms.com, sunsetproduce.com
(all varieties: beefsteak, campari, plum, cherry, globe, et cetera.)
Green Bean, hydrotaste.com

Grains

Barley, valcent.net
Corn, hydrotaste.com
Wheat, NASA
Rice, Pasona O2, Tokyo [underground production]

Herbs & Spices
abbreviated list

Banana Pepper, hydrotaste.com
Bay Leaves, freshzest.com
Chile Peppers, hydrotaste.com
Chives, freshzest.com
Cinnamon Basil, cahabaclub.com
Coriander, freshzest.com
Dill, Richard Stoner & grow-anywhere.com
French Tarragon, freshzest.com
Green Basil, freshzest.com
Lemon Basil, cahabaclub.com
Marjoram, freshzest.com
Mint, freshzest.com
Opal Basil, cahabaclub.com
Parsley, Big Red Strawberry Farm, Malaysia
Thai Basil, freshzest.com
Yellow Pea Shoots, cahabaclub.com

Leafy Greens
abbreviated list

Asparagus, asmith.id.au/index.html
Butterhead Lettuce, hydroserre.com/default.php
Broccoli, Richard Stoner & grow-anywhere.com
Brussels Sprout, hydrotaste.com
Cauliflower, hydrotaste.com
Celery, Richard Stoner & grow-anywhere.com, aeroponic
Charita Lettuce, valcent.net
Chinese Cabbage, Cornell University CEA,
Estelle Lettuce, valcent.net
Garlic Chives, Blue Harbor Plantation, Honduras
Green Coral Lettuce, Big Red Strawberry Farm, Malaysia
Peas, cahabaclub.com
Romaine Lettuce, Big Red Strawberry Farm, Malaysia
Spinach, Cornell University CEA
Swiss Chard, cahabaclub.com

Legumes

Peanuts, Lynette Morgan & Lynette Morgan & suntec.co.nz
Pistachios, Dr. Hillel Soffer @ UC Davis

Melons

Cantaloupe, nysunworks.org
Muskamelon, Taiwan Agricultural Research Center
Watermelon, Almeria, Spain

Root Vegetables

Beet, Richard Stoner & grow-anywhere.com
Belgian Endive, greenhousegrown.com
Carrot, Richard Stoner & grow-anywhere.com
Onions, Richard Stoner & grow-anywhere.com
Potato, hydrotaste.com
Radish, cahabaclub.com
Sweet Potato, NNT Urban Development, Japan

Shrubs & Trees
abbreviated list

Avocado, Lynette Morgan & suntec.co.nz
Banana, hydrotaste.com
Guava, Lynette Morgan & suntec.co.nz
Lemon, Disney's EPCOT
Lime, Lynette Morgan & suntec.co.nz
Nectarine, Lynette Morgan & suntec.o.nz
Peach, hydrotaste.com
Pepino Fruit, hydrotaste.com
Pineapple, Disney's EPCOT

Specialty Crops

Coffee, Lynette Morgan & suntec.co.nz
Grapes, Lynette Morgan & suntec.co.nz
Luffa Sponge, hydrotaste.com
Olives, Lynette Morgan & suntec.co.nz
Sunflower, hydrotaste.com
Tobacco, University of Kentucky
Wheat Grass, Richard Stoner & grow-anywhere.com

Vine Vegetables

Cucumber, University of Arizona CEA, hydroponic
Eggplant, greenhousegrown.com,
Okra, U. of Florida Institute of Food and Agricultural Sciences
Squash, hydrotaste.com
Sweet Bell Pepper, sunsetproduce.com
Zucchini, hydrotaste.com
Pineapple, Disney's EPCOT

It is also possible to grow cultivars of flowers, seeds and many other varieties of non-edible crop such as bamboo etc.

Business

Retail Value / Kg

	Crop type	Pick and Pay	Woolworths	Checkers	Spar	Fruit and Veg	Fresh Fruit Market	Plant Land	Average
1	Compost	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	20.00	R 20.00
2	Mushrooms	R 51.96	R 80.00	R 55.96	R 50.00	R 50.00	R 51.09		R 51.80
3	Hydroponics (Tomato Prices)	R 20.00	R 20.00	R 20.00	R 20.00	R 20.00	R 22.88		R 20.58

Farmers Prices

		Farmers Prices (25% Retail Value)	Price Per Ha	tons per year	Annual Estimated Commercial Value
1	Compost	R 4.50	n.a	1 914.53	R 8 615 390.52
2	Mushrooms	R 12.95	n.a	3 130.40	R 40 539 971.29
3	Hydroponics (Tomato Prices)	R 5.14	n.a	2 080.00	R 10 699 549.67

Commercial Target	Tons per year
Hydroponic Target	2 000.00
Mushrooms	3 130.40
Hydroponic Production	2 080.00
Total	2 080.00
Target Reached	YES

Grosse Annual Income			R 59 854 911.48
Less: Operating Income (12.5%)			R 7 481 863.94
Less: Labour	Mushrooms	R 505 700.00	
	Hydroponic	R 440 700.00	R 440 700.00
Upkeep		R 550 000.00	R 550 000.00
Nett Annual Income			R 51 382 347.55

Esitmated Final Building Cost **R 221 860 464.20**

Return on Investment (First Year) **23.16%**

Figure 182: Preliminary profits and building cost estimates [author, 2010].

The estimated production capabilities and current prices for these crops are estimated to determine if there is any actual economic value in the project. The building costs were estimated as if the design is on a high end of the scale of commercial construction because of the various unknown factors of the inherent systems and components of hydroponic farming and bamboo construction. This estimate is also for a current scenario (the year 2010) and the return on investment and profit margins, but these do not include any escalations for the 15 year window before the building is finally completed. The aim is merely to determine the possibility of the project to be a real business opportunity. The final figures will have to be determined by a specialist and some variation is expected.

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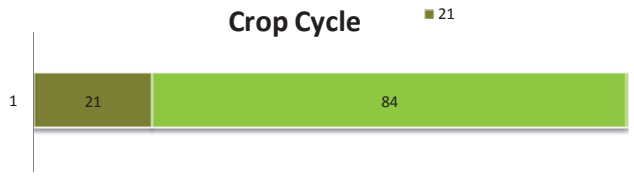
Processes

Phases

		Days	notes
A	Production of substrate (compost)	14	away from public (odours)
B	Peak Heating or Pasteurisation (compost)	7	
C	Spawning Process	10	
D	Growing Process	21	**first flush: 21 days** thereafter 7 day
E	Packing Process	na	
F	Store/Refrigerate (max)	7	

non harvest days per year per crop	50
annual non-harvest factor	14%
Crop Cycle (days)	84
Harvest Cycle (days)	7
Harvests per crop	6
crops per year	3
Rooms Required per year for daily harvests	5
Compost Required Every (X) Weeks	12
Loss Factor for non-harvest period	14%
(21 days growing per crop until first flush)	
Yield kg/day/m² from crop land	3
Worker can harvest kg / day	16
Yield per week per m² (kg/m² per 7 working days)	112.00



Requirements

Minimum Spacial Requirements

Composting and Pasturising Areas

Compost Provided every 21 days	tons	*l (mm)*	*area (m²)*	*volume* (m³)	notes
Required depth of compost		150.00			
Total Compost Required per Growing Room (crop area per growing room)			400.00	10.00	1m³ organic waste : 0.58 m³ compost material
total tons required per growing room ((@475 kg compost / organic matter = m³)	5				20.00
Total Pasturising Area required for composting (0.475m³ = 1 ton compost)	**5.00**		**5.00**		

Spawning Areas

	units	mm	m²	m³	
Spawn required per growing room (crop area per growing room)			400.00		
Fully Grown Spawn Storage required per growing room (shelf spacing @300mm)			50.00		
% m² spawn area required per m² growing area	**12.5%**				
total crop area (shelves) provided	1 100.00		4 400.00		
total spawn room area (shelves) required	**137.50**		**550.00**		

Packing Areas

	kg	mm	m²	m³	
Harvest area per day	9 460.00		3 784.00		
Kg packed per day = Kg harvest per day	9 460.00				
Kg per worker packed per day (180kg/hour)	1 440.00				
Harvest area packed per day			360.00		
Paking Area Required (360m² harvest packed per day per worker)			**10.51**		

Refridgeration Areas

		mm	m²	m³	
Kg per worker packed per day (180kg/hour)	1 440				
punnets packed per day (250g per punnet)	2 880				
number of punnets to 1 kg	4	0.12	0.03	0.01	
Space Required per day (kg packed x punnet per kg)			7.68	20.74	(ceiling height 2.7m)
Max number of days to be stored	10				
Max refridgerated space required			**76.80**	**207.36**	(ceiling height 2.7m)

Figure 183: Mushroom occupation - part one [author, 2010].
The expected occupation schedule for the mushroom crop.

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Occupation

Accommodation Schedule

SANS 0400 Classification	Area	Code	Name	Description	Occupation m²	Rooms	subtotal	no rooms x m² per room	Workers Required per room	subtotal	total	notes
D2	Composting	A	Prewetting area	Water tank: For keeping fresh water and soaking of straw.	60.00	1	60.00		2	2		
		A	Composting yard	Required for compost preparation	40.00	1	40.00	100.00	2	2	4	
	Pasturising	B	Boiler room	Required for pasteurization of compost.	14.00	1	14.00		1	1		
		B	Pasteurization tunnel	Required for pasteurization and conditioning of composting	5.00	1	5.00		1	1		
		B	Casing soil chamber	For pasteurization of casing soil.	9.00	1	9.00	28.00	1	1	3	
	Spawning	C	Boiling and Sterilzation	Washing, boiling and sterilization of grains are performed in this room. For this purpose, boiling cattle and autoclave is required.	16.00	1	16.00		1	1		
		C	Spawn Lab :Inoculation	laminar flow is placed which is used for inoculation of pure culture into bottles for preparation of master spawn and further multiplication of master spawn into commercial one	25.00	1	25.00		1	1		
		C	Spawn Lab: Incubation	After inoculation, master and commercial spawn are shifted to incubation room for growth and colonization of fungal mycelium. This room is fitted with air conditioner. Therefore, temperature of this room could be adjusted as per requirement of mushroom species.	25.00	1	25.00		1	1		
		C	Spawn storage	Fully colonized mushroom spawn is shifted to storage room where temperature is maintained to 40C.	50.00	1	50.00		1	1		
		C	Spawn lab.		20.00	1	20.00	136.00	1	1	5	80m² per worker x shelves x floors
	Growing	D	Growing room	For growing of Mushroom crops (yield determined by this area)	80.00	4	320.00	1 280.00	1	4	60	
	Packing	E	Packing room	For packing of mushrooms	10.00	1	10.00		4	4		
		E	Packaging store room	Storage of packaging materials	6.00		0.00					
								10.00			4	
	Refridgerate / Store	F	Refridgerated room	Storing of final product: packed fresh mushrooms, 10 days max	76.80	1	76.80		0	0		
		F				1	0.00	76.80	0	0	0	
	Management	G	Office	Open plan management and marketing office; computer control room	15.00	1	15.00		3	3		
		G	Staff Ablutions and Lockers	Male, Female		1	0.00	15.00	2	2		
G1	General Amenities					1	0.00		0	0		
		G	Stores/tool room	To keep the hand tools and equipments required for mushroom farm.	9.00	1	9.00		0	0		
		G	General Stores		9.00	1	9.00		0	0		
		G	AC compressor room/generator	For keeping compressor, cooling tank, motor and electric panel, gen-set and diesel.	34.00				0	0	5	
											20.00	

Total Factory Floor **1 645.80** **Total Workforce** **108.00**

Figure 184: Mushroom occupation - part two [author, 2010].
The expected occupation schedule for the mushroom crop.

Phases

		Days	notes
A	Compost Provision	21	
B	Growing Process	56	12 weeks per crop
C	Packing Process	1	
D	Store/Refrigerate (max)	na	

Processes

Maximums		Source
crops per year	3.60	Vertical Farm
harvest index	30%	
Crop Cycle (days)	56	
Harvest Cycle (days)	21	
hydroponic ton / hectare / year	750.00	Vertical Farm
Kg per m² per crop season	50.00	Vertical Farm, Morkel Combrink
Worker can harvest kg / week	3 360	
Workers required	11.90	
area picked per worker per week	168.00	
per day	33.60	
persons fed per year / ton	18.20	Vertical Farm
persons fed per year / hectare	13 650.00	
tons / month / hectare	62.50	
If I provide (X) per year	2 080.00	
I feed (X) people per year	37 856.00	
distance between plants (mm)	400.00	
space per plant (m²)	0.20	

Requirements

Minimum Spacial Requirements

Composting Provision							notes
Compost Provided Every 56 Days	**tons**	**units**	***d* (mm)**	***d* (m)**	***area* (m²)**	***volume* (m³)**	1m³ organic waste : 0.58 m³ compost material
Weekly biomass provided (Harvest Index)	74.29						
total compost matter provided per week						156.39	475 kg compost = org matter m³
1m³ organic waste : 0.58 m³ compost material	90.71			4.00	39.10	0.50	
Total compost provided 8 weeks	**90.71**			0.50	39.10	0.86	depth of 500mm

Growing Process							
Typical	**units**	***d* (mm)**	***b* (mm)**	***h* (mm)**	***area* (m²)**	***volume* (m³)**	I want to provide X tons a week
Ton per m²	0.05				1.00		
m² required per ton per week					800.00		40.00
harvest area (area required for ton required per week x 52 / crop cycle)					11 555.56		
							160.00
levels of building	7.00				1 650.79		**2 080.00**
number of crops	14.44						
number of summer crops	7.22						
Total Production area Hydroponic Building					**11 555.56**		

Packing Areas							
	tons	**units**	***d* (mm)**	***d* (m)**	***area* (m²)**	***volume* (m³)**	need to process X tons a week
pallet size	2.00			1.10	1.20	1.32	
stacked pallets required		20.00			24.00	26.40	40.00
number of 6m containers (approx 9 tons) per week		18.00					
Washing Process Automated							stacking space + 2m² workspace x nr of workers
Workers required (750kg per day)		54.00					
Total Packing Space					**108.00**		

Refridgeration / Store Areas						
			mm	**m**	**m²**	**m³**	
stacked pallets required		20.00			24.00		pallets stacked 3 high
Store room Areas Per Week (pallets per day)					**24.00**		

Figure 185: Tomato occupation - part one [author, 2010].
The expected occupation schedule for the hydroponic tomato crop.

Accommodation Schedule

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Occupation

SANS 0400 Classification	Area	Code	Name	Description	m²	Number of Rooms	subtotals	m² no rooms x m² per room	Workers Required per room	subtotals	total
D2	Growing	D	Crop Area	Weekkly m² harvested	800.00	1			na	12	
							11 555.56	11 555.56			12
	Packing	E	Packing room	For packing and washing of hydroponic crops	108.00	1	108.00		2	2	
		E						108.00			54
	Refridgerate / Store	F	Refridgerated room	Storing of final product	24.00	1	24.00		1	1	
		F				1	0.00	24.00	1	1	2
	Management	G	Office	Open plan management and marketing office; computer control room	12.00	1	12.00		3	3	
		G	Staff Ablutions and Lockers	Male, Female	0.00	2	0.00	12.00	1	2	
G1	General Amenities	G	Stores/tool room	To keep the hand tools and equipments required	9.00	1	9.00		0	0	
		G	General Stores		9.00	1	9.00		0	0	
		G	Public Sales Point		4.00	1	4.00	22.00	1	1	
		G	AC compressor room/generator room/Electric cabin.	For keeping compressor, cooling tank, motor and electric panel, gen-set and diesel.	34.00	1	34.00	34.00	0	0	
											6
									extra staff		20.00
							Total Floor Area	11 755.56	Total Workforce		93.90

Figure 186: Tomato occupation - part two[author, 2010].
The expected occupation schedule for the hydroponic tomato crop.

Water Energy

Consumption, Requirements and Potential

1 Food Factory

NBR Sanitary Requirements

	Population	Male				Female		notes
Factory Workforce	300	WC	WHB	Urinals	Showers	WC	WHB	Showers	Building Classification : D 2 - Moderate Risk Industrial (SABS 0400-1990:34)
NBR Requirements		3	6	5	n.a	9	5	n.a	population 120+: +1 for every 50 people
Min Total Required		7	10	9	n.a	13	9	n.a	

	Population	WC	WHB	Urinals	Showers
Required Total	300	20.00	19.00	9.00	0.00
Provided Total		**30.00**	**30.00**	**0.00**	**0.00**

1 Food Factory

Consumption

Non-Production Orientated Requirements	Purpose	No. of Fixtures	Litres Used per Fixture	Est. No. of Times Used Daily	Est. Total Daily (Litres)	Daily 1000 Litres	Monthly 1000 Litres
Cloakrooms	WC	30	7.00	5.00	1 050.00	1.05	31.50
	WHB	30	4.00	3.00	360.00	0.36	10.80
	Urinals	0	1.00	3.00	0.00	0.00	0.00
	Showers	0	100.00	2.00	0.00	0.00	0.00
Other (Kitchen, Laundry, Scullery)	Sink (Kitchen)	3	7.00	4.00	84.00	0.08	2.52
	Sink (Other)	10	7.00	4.00	280.00	0.28	8.40
	Dishwasher	2	20.00	5.00	200.00	0.20	6.00
				Subtotal	1 974.00	1.97	59.22
Production Orientated Requirements							
Food Factory	Mushrooms	n.a	n.a	n.a	56 000.00		
	Hydroponic Factory	n.a	n.a	n.a	145 600.00		
				Subtotal	201 600.00	201.60	6 048.00

Tank Sizes

Min Monthly Requirement (1000	Max Monthly Catchment (1000	Max Value (1000 Litres)	notes
59.22	346.80	**346.80**	Daily Requirements used to calculate tank sizes
Min Daily Requirement (1000	**Max Daily Requirement (1000**	**Max Value (1000 Litres)**	Use the Maximum value to determine minimum tank size (for Rainfall)
1.97	205.55	**205.55**	
Typical Tank Capacity	**number required**	**Diameter (mm)**	Tanks to be pumped full daily
Slimline (750 litre)	462.40	750.00	Slimline Stacked (two rows heigh)
5 500 Litre Tanks	63.10	1 800.00	
10 000 Litre Tanks	34.70	2 200.00	
15 000 Litre Tanks	23.20	2 600.00	
20 000 Litre Tanks	17.40	2 600.00	
50 000 Litre Tanks	10.00	custom	

Daily Requirements used to calculate tank sizes

Landscape irrigation to be determined by specialist

	Daily 1000 Litres	Monthly 1000 Litres	Yearly 1000 Litres
Total Consumption Requirements	**205.55**	6 166.44	73 997.28

Figure 187: Water energy - part one [author, 2010].
The expected water energy in consumption and storage facilitation.

Rainfall Chart

Pretoria	Annual Rainfall Statistics									Annual Rainfall Statistics			
Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Ave Rainfall (mm)	136.00	75.00	82.00	51.00	13.00	7.00	3.00	6.00	22.00	71.00	98.00	110.00	56.17
Ave Rainfall (m)	0.14	0.08	0.08	0.05	0.01	0.007	0.003	0.01	0.02	0.07	0.10	0.11	0.06

	Monthly Catchment Potential									Monthly Catchment Potential			Annual Average
Roof Area Name	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres
Hydroponic Roof Area	346.80	191.25	209.10	130.05	33.15	17.85	7.65	15.30	56.10	181.05	249.90	280.50	143.23
Total Roof x Litres/month	**346.80**	**191.25**	**209.10**	**130.05**	**33.15**	**17.85**	**7.65**	**15.30**	**56.10**	**181.05**	**249.90**	**280.50**	**143.23**

Monthly Catchment Potential													Annual Average
		1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres	1000 Litres
Total building water requirements (Productive Processes and Non-Productive Processes)	Total Monthly Requirements of factory Met?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Difference	-5 819.64	-5 975.19	-5 957.34	-6 036.39	-6 133.29	-6 148.59	-6 158.79	-6 151.14	-6 110.34	-5 985.39	-5 916.54	-5 885.94	-6 023.21
ONLY Non-Productive Processes (grey water)	Non-Productive Monthly Requirements of factory met?	59.22	59.22	59.22	59.22	59.22	59.22	59.22	59.22	59.22	59.22	59.22	59.22	
		YES	YES	YES	YES	NO	NO	NO	NO	NO	YES	YES	YES	
	Surplus Per month	287.58	132.03	149.88	70.83	-26.07	-41.37	-51.57	-43.92	-3.12	121.83	190.68	221.28	84.01
	Surplus Carried over to next month	287.58	360.39	451.05	462.66	403.44	344.22	243.63	184.41	125.19	187.80	319.26	481.32	74.36
	Can it sustain?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	

Self-Sustaining Grey water Recycling System

				Gutter Size		Min Standard Size	Recommended	Down pipe Size		Recommended
				Max Area Served / Gutter	Gutter Size (140mm²/m²)	Pipe Size Ømm	Pipe Size Ømm	Area Served / Down pipe	Down pipe Size (100mm²/m²)	Ømm
How much can Rainwater Catchment meet the daily requirements of the non-productive processes of the building?	**YES**	**108%**	of monthly non-productive processes can be sustained by RAINWATER	54.54	87.38	round up value to meet nearest standard	100.00	64.80	80.50	100.00
Can Rainwater Catchment sufficiently sustain TOTAL grey water Requirements of the building?	**NO**		The total building cannot be fulfilled by rainwater catchment of							

Figure 188: Water energy - part two [author, 2010].
The expected water energy in consumption and storage facilitation.

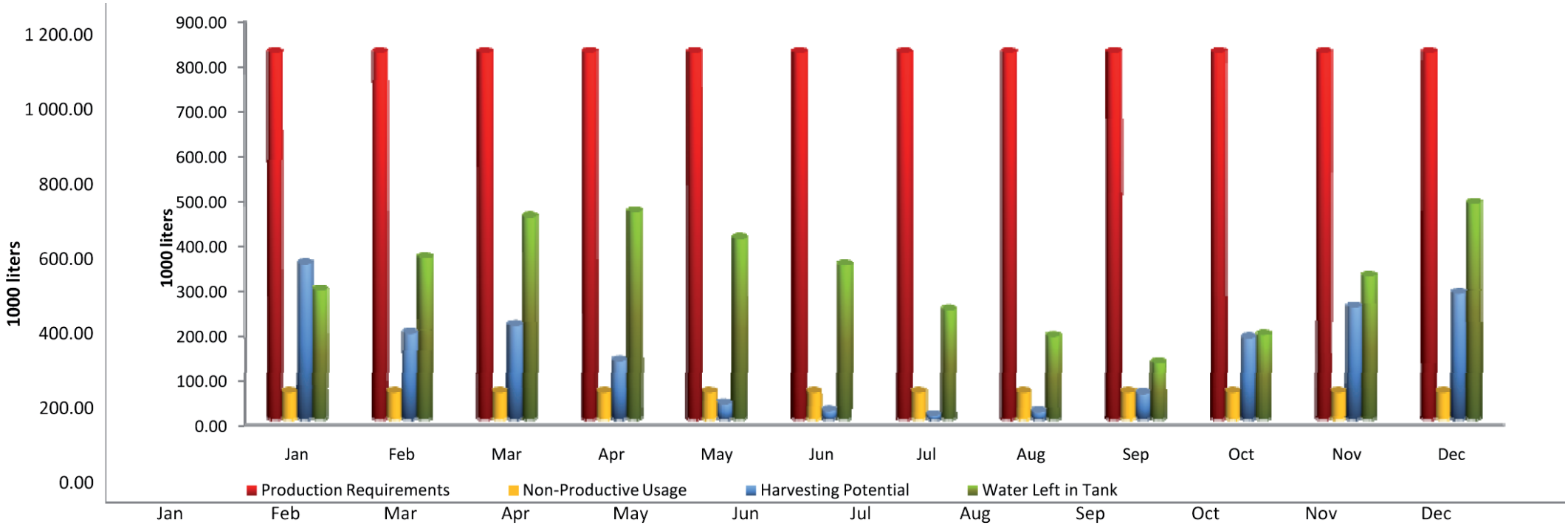

Figure 189: Figure illustrating water consumption pattern [author, 2010].
The expected water energy in consumption

Methane and Organic Storing Facilities, Composting

Biomass

Required by System	Crop	Cycle	tons per cycle	tons per week	Weekly	notes
Composte Required (Mushrooms)	Mushrooms	every 3 weeks	5	1.67	every week	The composting process takes 3 weeks, storage wil be calculated according to 3 week cycles
Compost Required (seedlings)	Seedlings	every week	6	6.00	every week	
Total Required		every 3 weeks	23.00	7.67	every week	475 kg organic matter = 1 m³ organic matter
Provided by System		**Cycle**	**tons per cycle**	**tons per week**	**Weekly**	
Organinc Waste Processed (every 3 weeks)		every 3 weeks	**396.71**	76.70	every week	
Compost Provided (every 3 weeks)		every 3 weeks	230.09	44.48	every week	1m³ organic waste : 0.58 m³ compost material
Surplus		every 3 weeks	207.09	**36.82**	every week	

Organic Waste Storage Space

every 3 weeks	*number of towers*	*h* (mm) per bin	*area* (m²) per bin	*volume required* (m³)	
Compost Towers	14.00	1.40	1.20	188.44	For every 1500 ton organic waste, 105 ton = methane gas (10%)
total area required @ height 1.2 m bins		volume per tower	157.03		
number of bins (bin @ 1.5m², / number of floors)		11.76	20.94	164.64	The composting process takes 3 weeks, storage wil be calculated according to 3 week cycles
Storage Space for surplus compost		3.00	**32.79**	98.37	Surplus compost can also be worked into the landscape park

Methane Gas Storage Space

Weekly	*liters*	*area* (m²)	*volume* (m³)	
Liters Consumption	14 362.80	7.18	14.36	1ton = 150m³ (65-75% methane) = 3.15 kWh per m³
Liters Provided	19 835.57	9.92	19.84	1000 liters per m³
Methane Storage Area Required		**9.92**		Gas Sent to Methane Reactor converted into Electricity (normal Diesel Generator can be transformed to process gas)
Methane Processing Area required		**9.92**		
Weekly	*liters*	*area* (m²)	*volume* (m³)	Gas either consumed on site, retailed or electricity replace into city grid
Daily Gas Use	2 051.83	1.03	2.05	
Daily Gas Consumption	2 833.65	1.42	2.83	

Sustainable Composting Conditions Met **YES**

Figure 190: Compost requirements [author, 2010].
The expected biomass energy and compost requirements.

Resource Schedule

Mushrooms

Energy Requirements

Electric Energy	Crop area	Lighting Hours	W / m² (1 W/f² = 25 W / m²)	KWh (kWh/m²/Hours)	Type of Light	notes	notes
m² energy needed	4 000.00		100 000.00	100.00	flourescent	Vertical Farm	Aerobic process, can be aided by sunlight or artificial means to reach 62ºC
lighting hours		8.00				crop area (m²) x W per m² x number of ligthing hours	
Daily			800 000.00	800.00			Requires auger or similar machinesed turning device (every 2 days)
Weekly			5 600 000.00	5 600.00			
Montly			22 400 000.00	22 400.00			**Method 1**: 6 hours @ 62ºC, 7th hour cool down with 2ºC (day1), thereafter cooldown till 23ºC is reached by day 14
Annual			**268 800 000.00**	**268 800.00**			
Water	Crop area	Water (liters / m² / day)					
	4 000.00	2.00					**Method 2**: 50ºC for 5 days, thereafter cooldown till 23ºC is reached by day 14
Daily		56 000.00					
Montly		224 000.00					
Annual		2 688 000.00					
Waste	Tons	Harvest Index	Biomass Produced (tons)	Methane (m³)	Potential (kWh)		
Weekly	8.60	0.35	15.97	10 780.71	2 997.04	1 m³ methane gas = 0.278 kWh	
Montly	34.40		63.89	43 122.86	11 988.15		
Annual	412.80		766.63	517 474.29	143 857.85	kg per week *150 liters per kg (conservative)* 0.5	

Resource Schedule

Tomatoes

Energy Requirements

Electric Energy	Crop area	Lighting Hours	W / m² (1 W/f² = 25 W / m²)	KWh (kWh/m²/Hours)	Type of Light	notes
m² energy needed	11 555.56		124 511.11	124.51	LED	ligthing hours per m²
lighting hours		12.00				crop area (m²) x W per m² x number of ligthing hours
Daily			1 494 133.33	1 494.13		
Weekly			10 458 933.33	10 458.93		
Montly			41 835 733.33	41 835.73		
Annual			**502 028 800.00**	**502 028.80**		
Water	Crop area	Water (liters / m² / day)				
	11 555.56	1.80				
Daily		145 600.00				
Montly		582 400.00				
Annual		6 988 800.00				
Waste	Tons	Harvest Index	Biomass Produced (tons)	Methane (m³)	Potential (kWh)	
Weekly	40.00	0.35	74.29	50 142.86	13 939.71	1 m³ methane gas = 0.278 kWh
Montly	160.00		297.14	200 571.43	55 758.86	kg per week x 150 liters per kg (conservative) x 0. effieciency (Vertical Farm)
Annual	2 080.00		3 862.86	2 607 428.57	724 865.14	

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Figure 191: Resource schedule [author, 2010].
The expected resource consumptions.

Energy Potential

Electric Energy Required

Energy Requirements

1 Food Factory	Excess Biomass Produced (ton per week)	Weekly Operational Energy Required (kWh)	Montly Operational Energy Required (kWh)	Yearly Operational Energy Required (kWh)
Mushrooms	15.97	5 600.00	22 400.00	268 800.00
Hydroponic Factory (Tomato Calculations)	74.29	10 458.93	41 835.73	502 028.80
Offices and Laboratories	3.00	4 183.90	16 735.60	200 827.20
Est. HVAC Requirements	0.00	20 000.00	80 000.00	960 000.00
subtotal	**93.26**	**40 242.83**	**160 971.33**	**1 931 656.00**

2 On-site organic resources	Excess Biomass Produced (ton per week)	Weekly Operational Energy Required (kWh)	Montly Operational Energy Required (kWh)	Yearly Operational Energy Required (kWh)
Landscape Maintanance	1.00	2 500.00	10 000.00	120 000.00
Human Organic Waste (Factory Employees)	31.50	2 500.00	10 000.00	120 000.00
Animal Manure (Horses)	6.48	0.00	0.00	0.00
subtotal	39	5 000	20 000	240 000

	Excess Biomass Produced (ton per week)	Weekly Operational Energy Required (kWh)	Montly Operational Energy Required (kWh)	Yearly Operational Energy Required (kWh)
subtotal	**132.24**	**45 242.83**	**180 971.33**	**2 171 656.00**

Electric Energy Provided

1 Food Factory	Weekly Potential: Methane (m³)	Weekly Potential: Potential (kWh)	Monthly: Potential (kWh)	Yearly: Potential (kWh)	Weekly: Remainder (kWh)	Montly: Remainder (kWh)	Yearly: Remainder (kWh)
Mushrooms	2 395.71	7 546.50	30 186.00	362 232.00	1 946.50	7 786.00	93 432.00
Hydroponic Factory (Tomato Calculations)	11 142.86	35 100.00	140 400.00	1 684 800.00	24 641.07	98 564.27	1 182 771.20
Offices and Laboratories	450.00	1 417.50	5 670.00	68 040.00	-2 766.40	-11 065.60	-132 787.20
Est. HVAC Requirements	0.00	0.00	0.00	0.00	-20 000.00	-80 000.00	-960 000.00
subtotal	**13 988.57**	**44 064.00**	**176 256.00**	**2 115 072.00**	**3 821.17**	**15 284.67**	**183 416.00**

2 On-site organic resources	Weekly Potential: Methane (m³)	Weekly Potential: Potential (kWh)	Weekly: Remainder (kWh)	Montly: Remainder (kWh)	Yearly: Remainder (kWh)
Landscape Maintanance	150.00	472.50	-2 027.50	-8 110.00	-97 320.00
Human Organic Waste (Factory Employees)	4 725.00	14 883.75	12 383.75	49 535.00	594 420.00
Animal Manure (Horses)	972.00	3 061.80	3 061.80	12 247.20	146 966.40
subtotal	5 847	18 418	13 418	53 672	644 066

	Methane (m³)	Potential (kWh)	Weekly	Montly	Yearly
subtotal	**19 835.57**	**62 482.05**	**17 239.22**	**68 956.87**	**827 482.40**

Total

	Remainder	Remainder	Remainder (MWh)
MWh Required	45	181	2 172
MWh Potential	62	250	2 999
Methane Required	14 363	57 451	689 415
Methane Provided	19 836	79 342	952 107
MWh Surplus	17	69	827
Methane (m³)	5 473	21 891	262 693
Liters	5 473	21 891	262 693

Potential Electrical Conditions Met **YES**

% Potential Electrical **138.10%**

Figure 192: Latent energy potential [author, 2010].
The expected energy potential from bio-gas production.

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