Training Workshop on Data Acquisition and Dataset Development for Life Cycle Inventory

Exercise 1 - Primary raw data acquisition and modeling

Data for producers:[1]

The dataset covers all relevant steps involved with a Mango production from cradle-to-gate, i.e. all processes from raw materials extraction till Mango harvesting are taken into account.

PART 1.1 – Primary data collection

You are a successful producer that started your 20ha Mango plantation about 7 years ago, for that you needed to start from scratch and buy a piece of land that still had a forest on it, thus, first of all it was necessary to clean the "fields".

Preparing the field for the plantation demanded machines to cut the trees and prepare the fields, electricity to power some machinery, diesel and land.

The machines can clean and prepare 263 ha of field during its lifetime which means that for your Mango plantation only 0.076 Machine units were necessary.

In total 13360 kW of electricity to power machines working 4 hours per hectare was needed.

13360/4 = 3340 kWh per 20 ha

3340/20 = 167 kWh /ha

Necessary materials and resources		
Electricity	167	kWh
Tree cutting machine	0.0038	Units
Diesel	1.61	MJ
Land	1	ha

In the End of this process you had 20ha of clean and prepared field, 1000m³ of Biomass coming from the cut trees that need to be disposed and emissions of pollutants to the air in a low populated area.

Products / by-products / waste		
land, prepared for tree growing	1	ha
Biomass	50	m³

Emissions to air per hectare		
CO_2 (biogenic)	21.14	Kg
N_2O	2.6	Kg
CO_2 (fossil)	78.58	Kg
PM (particulate matter)	15	Kg

PART 1.2 - Primary data collection

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[1] This fact sheet describes a simplified Mango production farm based on data from EcoInvent and Agribalyse databases.

After preparing the field you needed to start your production, for this step you needed to consider again all the necessary resources and materials.

The plantation needs irrigation through the whole year, each plant consumes 100 liters of water per week and there is a total of 140 plants per hectare.

You expect you can produce Mangos on this field for at least 25 years.

WATER:

Assumed water consumption: 100 liters per plant per week (140 plants per hectare), irrigation through the whole year:

100*140*52 = 728,000 l = 728 m3/ha/year

Water consumption: 728/15 = 48.53 m3/t = 0.04853 m3/kg

The irrigation system uses a 2.5kW pump per hectare that works every day for 12h.

ELECTRICITY:

One engine/pumping station that powers the irrigation machine, with a power of 2.5 kW; the irrigation machine works every day, but only half day (=8760/2=4380h):

4380 * 2.5 = 10,950 kWh/year

Electricity use: 10,950/15 = 730 kWh/t = 0.73 kWh/kg

The land needs to be fertilized every year, therefore 111.9 kg of fertilizer is applied to each hectare of cultivated land per year.

FERTILIZER:

111.9/15 = 7.46 kg of fertilizer per 1000kg Mango produced

Fertilizer use: 0.00746 kg/kg (Mango)

Land use change: 10000m²/15000kg Mangos/25years = 0.0267 m² land use change per kg Mango

DATA:

Mango production area: 20 ha

Annual yield: 15 t/ha/year

Necessary materials and resources		
Electricity for irrigation	0.73	kWh
Fertilizer (Phosphate P2O5)	0.00746	kg
Pesticides	8.82E-05	kg
Water for irrigation	0.04853	m³
Transport of fertilizers and pesticides to plant	200	km
Land use change	0.0267	m²

Products / by-products / waste		
Mango	1	kg

Emissions per kg of Mango		
Phosphate emissions to groundwater	2.09E-06	kg
Pesticides emissions to soil	8.82E-05	kg

PART 2 – Allocation

In the end of the harvest you have 2 products:

- Mangos for selling at the market
- Mangos that are too ripe and can only be consumed after being processed (jams, dry mango snacks, Mango pickles, etc.)

The main product is the Market mango and the Ripe mango is the by product which is 15% of the production and is responsible for 5% of the farm income.

Because 2 products are generated the environmental burdens need to be correctly split between them. There are many ways of doing it but we will check the results for mass allocation and economic allocation.

Mass allocation:

1 ton of Mango = 850 kg of Market mango + 150 kg of Ripe mango, but emissions are for 1 kg of Mango

Products / by-products / waste		
Market mango	0.85	kg
Ripe mango	0.15	kg

Emissions per kg of Mango		
Phosphate emissions to groundwater	2.09E-06	kg
Pesticides emissions to soil	8.82E-05	kg

Mass distribution		
Market mango	85	%
Ripe mango	15	%

Emissions per product		
Phosphate emissions to groundwater	1.78E-06	kg
Pesticides emissions to soil	7.50E-05	kg
Phosphate emissions to groundwater	0.31E-06	kg
Pesticides emissions to soil	1.32E-05	kg

Economic allocation:

Market mango is worth Rs. 500/kg while Ripe mango is worth Rs. 25/kg

Products / by-products / waste		
Market mango	500	Rs
Ripe mango	25	Rs

Emissions per kg of Mango		
Phosphate emissions to groundwater	2.09E-06	kg
Pesticides emissions to soil	8.82E-05	kg

Mass distribution		
Market mango	95	%
Ripe mango	5	%

Emissions per product		
Phosphate emissions to groundwater	1.99E-06	kg
Pesticides emissions to soil	8.38E-05	kg
Phosphate emissions to groundwater	0.10E-06	kg
Pesticides emissions to soil	0.44E-05	kg

Data for dataset producers:

You were recently hired to create datasets for mango producers that are interested in modeling their production chain from cradle to gate.

To create the datasets you will need all the information about the elements involved in Mango production since raw materials extraction and preprocessing until the harvest or storage of Mangos.

There are many ways of obtaining such information but the best way, in order to create a reliable dataset, is to go to the source i.e. interview the mango producers and find out what they need for their production.

It is worth noticing that the dataset may consist of more than one process and although for this exercise all producers cultivate mangos the same way, in reality there are several ways of producing the fruit, manure the soil, irrigate and so on.

To create your dataset, take the empty data collection formulary and interview one of the mango producers that should provide you a high quality primary data.

Define a quantitative reference and mind units and amounts while collecting the data.

(Handout: empty formulary from excel table)

Exercise 2 – Secondary Data

Apart from the primary data, secondary data is also necessary to model processes and attribute the necessary environmental burdens to them. Usually Electricity and Transport are secondary datasets that can be obtained from public databases and other sources, as this data is easily found on the internet, for instance on governmental websites or on scientific literature.

The figures below are screenshots from the Sri Lanka Sustainable Energy Authority[2], and the NATION newspaper, both are public data sources for the Sri Lanka energy mix dataset you want to create.

However, for the dataset you also need to account for the emissions from the energy production which are not provided and might require more research.

Take a look on the data provided and create an Energy Mix for Sri Lanka, it should be representative for the time period of 2015-2016.

Energy mix:

Sri Lanka Energy Balance
Compiled by Sri Lanka Sustainable Energy Authority

Home | Electricity | Petroleum Products | Biomass | Energy Balance | Economic Indicators | Grid Emission | Conversion Factors | Coal

Home
Electricity Data
- Overview
- Electricity Generation
- Own Use in Power Plants and Network Losses
- Fuel Consumption in Power Plants
- Electricity Sales by Sector
- Capacities of Power Plants
- Electricity Tariff
- Customers, Employees and Finances
- System Load Profile

Petroleum Data
Biomass Data
Energy Balance
Energy-Econ Indicators
Grid Emission Factor
Conversion Factors
Coal

Gross Electricity Generation (GWh)

Select Year 2011 to 2015 Update Table Export to Excel

Links

Gross Generation of Thermal Power Stations
Gross Generation of Hydro Power Stations

CEB-Hydro (GWh)

	2011	2012	2013	2014	2015
Major Hydro	3,906.96	2,684.17	5,936.61	3,618.83	4,825.65
Small Hydro	65.72	42.55	73.49	30.89	78.76
Sub Total Hydro	3,972.67	2,726.72	6,010.10	3,649.72	4,904.41

CEB Non-Conventional (GWh)

	2011	2012	2013	2014	2015
CEB Wind	2.66	2.32	2.32	2.13	1.07
Sub Total Non Conventional	2.66	2.32	2.32	2.13	1.07

CEB-Thermal (GWh)

	2011	2012	2013	2014	2015
Steam - Fuel Oil	0.00	0.00	0.00	0.00	0.00
Steam - Coal	1,027.62	1,399.12	1,465.39	3,505.55	4,447.21
Steam - Diesel	10.49	4.61	3.98	19.40	9.97
Sub Total Steam	1,038.11	1,403.74	1,469.37	3,524.95	4,457.18
Diesel Engine - Residual Oil	903.37	921.55	559.81	647.10	271.93
Diesel Engine - Fuel Oil	0.00	0.00	111.48	95.69	87.94
Diesel Engine - Diesel Oil	14.19	9.42	27.26	9.31	22.48
Sub Total Diesel Engines	917.56	930.97	698.55	752.09	382.34
Gas Turbines - Diesel Oil	320.33	218.20	17.58	241.88	25.07
Gas Turbines - Naptha	0.00	0.00	0.00	0.00	0.00
Sub Total Gas Turbines	320.33	218.20	17.58	241.88	25.07
Combined Cycle - Diesel Oil	95.90	550.66	221.75	284.64	119.54
Combined Cycle - Naptha	159.78	329.05	388.53	465.54	540.26
Sub Total Combined Cycle	255.68	879.71	610.27	750.18	659.80

CEB - Sub Total (GWh)

	2011	2012	2013	2014	2015
Sub Total CEB Power plants	6,507.02	6,161.66	8,808.20	8,920.95	10,429.87

View Diagrams

Gross Electricity Generation - CEB Power Plants (GWh)

[2] http://www.info.energy.gov.lk/

Self Generation By Customers	0.00	0.00	0.00	0.00	0.00	Gross Electricity Generation Off Grid Systems (GWh)
Off Grid Systems-Industrial	0.00	0.00	0.00	0.00	0.00	
Off Grid Systems-Non Industrial	0.00	0.00	0.00	0.00	0.00	
Sub Total Off Grid - Conventional	0.00	0.00	0.00	0.00	0.00	

Off Grid Systems - Non Conventional (GWh)

	2011	2012	2013	2014	2015
Small Hydro, Industrial	7.07	7.07	7.07	7.07	7.07
Small Hydro, Household	3.58	3.69	3.69	3.69	3.69
Solar Photovoltaic, Household	7.60	8.01	8.01	8.01	8.01
Wind Energy, Household	0.01	0.01	0.01	0.01	0.01
Sub Total Off-Grid, Non-Conventional	18.26	18.77	18.77	18.77	18.77

Total Generation Sri Lanka

	2011	2012	2013	2014	2015
Total	11,599.87	11,897.62	12,024.32	12,848.88	13,225.55

Summary - 1 - CEB Grid

	2011	2012	2013	2014	2015
CEB Hydro	3,972.67	2,726.72	6,010.10	3,649.72	4,904.41
CEB Wind	2.66	2.32	2.32	2.13	1.07
CEB Thermal	2,531.68	3,432.62	2,795.78	5,269.10	5,524.39
IPP Thermal (Gross)	4,352.33	4,983.85	2,023.94	2,675.20	1,272.03
SPP Hydro	600.57	564.69	908.39	902.17	1,064.72
SPP Thermal	0.00	0.00	0.00	0.00	0.00
SPP Solar	1.11	2.00	1.68	1.47	1.87
SPP Biomass	31.63	22.17	26.39	41.39	57.31
SPP Wind	88.95	144.48	232.26	270.32	342.13
NmP Solar	0.00	0.00	4.69	18.60	38.84
Hired Thermal	0.00	0.00	0.00	0.00	0.00
Gross Generation to CEB Grid	11,581.61	11,878.85	12,005.55	12,830.11	13,206.77

Summary - 2 - CEB Grid

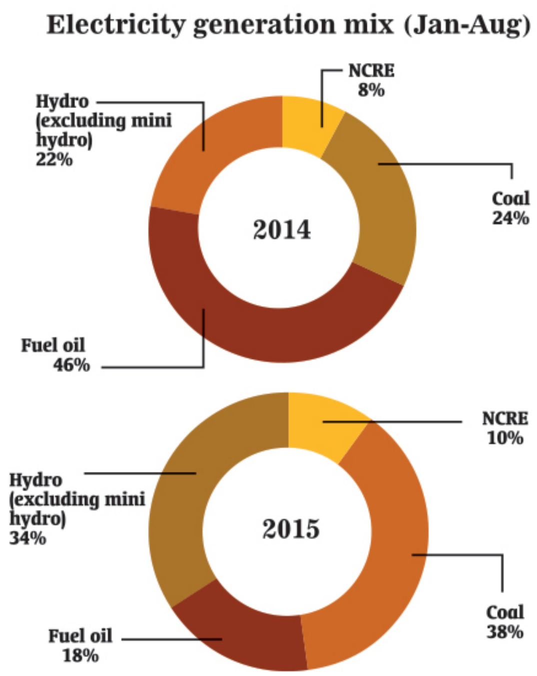
	2011	2012	2013	2014	2015
CEB Hydro	3,972.67	2,726.72	6,010.10	3,649.72	4,904.41
Thermal, CEB, IPP and Hired	6,884.01	8,416.47	4,819.72	7,944.30	6,796.42
CEB Wind	2.66	2.32	2.32	2.13	1.07
New Renewable Energy	722.26	733.34	1,168.72	1,215.36	1,466.04
Net-metered Projects	0.00	0.00	4.69	18.60	38.84
Gross Generation to CEB Grid	11,581.61	11,878.85	12,005.55	12,830.11	13,206.77
Generation Growth Rate: CEB Grid (%)	7.1	2.1	0.3	6.6	2.3

Summary- Sri Lanka

	2011	2012	2013	2014	2015
CEB Hydro	3,972.67	2,726.72	6,010.10	3,649.72	4,904.41
Thermal, CEB, IPP and Hired	6,884.01	8,416.47	4,819.72	7,944.30	6,796.42
CEB Wind	2.66	2.32	2.32	2.13	1.07
New Renewable Energy	722.26	733.34	1,168.72	1,215.36	1,466.04
Net-metered Projects	0.00	0.00	4.69	18.60	38.84
Self-Generation by Customers	0.00	0.00	0.00	0.00	0.00
Off-Grid, Conventional	0.00	0.00	0.00	0.00	0.00
Off-Grid, Non-Conventional	18.26	18.77	18.77	18.77	18.77
Gross Generation Sri Lanka	11,599.87	11,897.62	12,024.32	12,848.88	13,225.54
Generation Growth Rate Sri Lanka (%)	7.4	2.6	1.1	6.9	2.9

Sri Lanka's energy mix

By Azhar Razak - Mar 26, 2016



Sri Lanka's electricity demand per year is estimated to be at 2300 megawatts with the island's present generating capacity being around 3900 megawatts.

Hydroelectricity Currently, ten large hydroelectric power stations are in operation, with the single largest hydroelectric source being the Victoria Dam. Although a large portion of the country's hydroelectric resource is tapped, the government continues to issue small hydro development permits to the private sector, for projects up to a total installed capacity of 10 MW per project.

Thermal power Thermal power stations in Sri Lanka run on diesel, other fuel oils, naptha or coal. The Norochcholai Coal Power Station, the only coal-fired power station in the country, was commissioned in late 2011. The plant has since added 900 megawatts of electrical capacity to the grid.

Wind power The first commercial grid-connected wind farm is the 3 MW Hambantota Wind Farm, northwest of Hambantota. The government policy limit of 10 MW per wind project significantly decreases economies-of-scale, further straining such developments.

Solar power Grid-connected solar power has only recently been introduced. The only operational commercial-scale solar-powered facility is the Buruthakanda Solar Park of 1.2 MW, operated by the Sri Lanka Sustainable Energy Authority (SLSEA).

Geothermal power Geothermal power is under research, although no power stations of this type are operational.

Nuclear power The CEB has included a 600MW nuclear power plant as an option in its plans for 2031.

Source: http://nation.lk/online/2016/03/26/sri-lankas-energy-mix.html

Emissions:

After exhaustively researching you came to the conclusion that the detailed inventory of Sri Lanka energy production isn't available, therefore you decided to adapt datasets from other countries.

On ecoinvent you found the following datasets on which you could base Sri Lanka energy mix emissions, choose the dataset you find more appropriate to adapt to Sri Lanka.

electricity production, hydro, reservoir, alpine region | electricity, high voltage | cut-off, U

Inputs			
Flow	Category	Amount	Unit
Energy, potential (in hydropower reservoir), converted	Resource/in water	3.79	MJ
hydropower plant, reservoir, alpine region	4220:Construction of utility projects/4220a: Construction of utility pro...	4.04E-13	Item(s)
lubricating oil	192:Manufacture of refined petroleum products/1920:Manufacture of refine...	7.56E-06	kg
Occupation, water bodies, artificial	Resource/land	0.00345	m2*a
Transformation, from unknown	Resource/land	2.30E-05	m2
Transformation, to industrial area, built up	Resource/land	2.30E-07	m2
Transformation, to water bodies, artificial	Resource/land	2.28E-05	m2
Volume occupied, reservoir	Resource/in water	0.15	m3*a
waste mineral oil	382:Waste treatment and disposal/3822:Treatment and disposal of hazardou...	-7.56E-06	kg
Water, turbine use, unspecified natural origin	Resource/in water	0.81	m3
Outputs			
Flow	Category	Amount	Unit
Dinitrogen monoxide	Emission to air/low population density	7.70E-08	kg
electricity, high voltage	351:Electric power generation, transmission and distribution/3510:Electr...	1	kWh
Methane, biogenic	Emission to air/low population density	1.40E-05	kg
Water	Emission to air/unspecified	29.22168	kg
Water	Emission to water/unspecified	0.78078	m3

electricity production, wind, 1-3MW turbine, onshore | electricity, high voltage | cut-off, U

Inputs			
Flow	Category	Amount	Unit
Energy, kinetic (in wind), converted	Resource/in air	3.87	MJ
lubricating oil	192:Manufacture of refined petroleum products/1920:Manufacture of refine...	5.83E-05	kg
transport, freight, lorry 7.5-16 metric ton, EURO3	492:Other land transport/4923:Freight transport by road	4.31E-12	t*km

waste mineral oil	382:Waste treatment and disposal/3822:Treatment and disposal of hazardou...	-5.83E-05	kg
wind turbine network connection, 2MW, onshore	4220:Construction of utility projects/4220a: Construction of utility pro...	1.85E-08	Item(s)
wind turbine, 2MW, onshore	4220:Construction of utility projects/4220a: Construction of utility pro...	1.85E-08	Item(s)
Outputs			
Flow	Category	Amount	Unit
electricity, high voltage	351:Electric power generation, transmission and distribution/3510:Electr...	1	kWh

electricity production, hard coal | electricity, high voltage | cut-off, U

Inputs			
Flow	Category	Amount	Unit
hard coal	051:Mining of hard coal/0510:Mining of hard coal	0.63581	kg
hard coal ash	239:Manufacture of non-metallic mineral products n.e.c./2394:Manufacture...	-0.10858	kg
hard coal power plant	4220:Construction of utility projects/4220a: Construction of utility pro...	1.33E-11	Item(s)
SOx retained, in hard coal flue gas desulfurisation	351:Electric power generation, transmission and distribution/3510:Electr...	0.00073	kg
water, completely softened, from decarbonised water, at user	360:Water collection, treatment and supply/3600:Water collection, treatm...	0.0871	kg
Water, cooling, unspecified natural origin	Resource/in water	0.06639	m3
water, decarbonised, at user	201:Manufacture of basic chemicals, fertilizers and nitrogen compounds, ...	2.90323	kg
Outputs			
Flow	Category	Amount	Unit
Acenaphthene	Emission to air/low population density	6.10E-11	kg
Acrolein	Emission to air/low population density	3.47E-08	kg
…			

heat and power co-generation, biogas, gas engine | electricity, high voltage | cut-off, U

Inputs			
Flow	Category	Amount	Unit

biogas	382:Waste treatment and disposal/3821:Treatment and disposal of non-haza...	0.34433	m3
heat and power co-generation unit, 160kW electrical, common components for heat+electricity	4220:Construction of utility projects/4220a: Construction of utility pro...	3.91E-08	Item(s)
heat and power co-generation unit, 160kW electrical, components for electricity only	271:Manufacture of electric motors, generators, transformers and electri...	3.91E-08	Item(s)
heat and power co-generation unit, 160kW electrical, components for heat only	281:Manufacture of general-purpose machinery/2811:Manufacture of engines...	3.91E-08	Item(s)
lubricating oil	192:Manufacture of refined petroleum products/1920:Manufacture of refine...	0.00023	kg
waste mineral oil	382:Waste treatment and disposal/3822:Treatment and disposal of hazardou...	-0.00023	kg
Outputs			
Flow	Category	Amount	Unit
Carbon dioxide, biogenic	Emission to air/low population density	0.65358	kg
Carbon monoxide, biogenic	Emission to air/low population density	0.00038	kg
Dinitrogen monoxide	Emission to air/low population density	1.96E-05	kg
electricity, high voltage	351:Electric power generation, transmission and distribution/3510:Electr...	1	kWh
Methane, biogenic	Emission to air/low population density	0.00018	kg
Nitrogen oxides	Emission to air/low population density	0.00012	kg
NMVOC, non-methane volatile organic compounds, unspecified origin	Emission to air/low population density	1.57E-05	kg
Platinum	Emission to air/low population density	5.48E-11	kg
Sulfur dioxide	Emission to air/low population density	0.0002	kg

Assume this composition of the electricity production mix in Sri Lanka and calculate an overall data set based on the data sets listed above.

Electricity, high voltage, production mix - Sri Lanka				
Inputs				
Flow		Amount	Unit	%
electricity production, hydro		0.3714	kWh	37.14%
electricity production, wind		0.0008	kWh	0.01%
electricity production, nuclear		0.0000	kWh	0.00%
electricity production, fossil fuels and coal		0.5146	kWh	51.46%
electricity production, others (biomass, solar, etc.)		0.1139	kWh	11.39%
Outputs				
Flow	category	amount	unit	

electricity, high voltage	351:Electric power generation, transmission and distribution	1	kWh

Exercise 3 – National dataset development by adjustment

With the information obtained in the training, how would you create datasets that are representative for Sri Lanka for one of the following options, Rice production and milling, Tea production and processing or Dairy production?

Below you can find examples of sources for **Rice datasets.**

IRRI

Source: http://irri.org/our-work/locations/sri-lanka

Sri Lanka and IRRI started collaborating in 1960 through training and exchange of rice varieties. In 1967, an agreement between Sri Lanka and the Ford Foundation led to a two-year program between IRRI and the country's Department of Agriculture where its scientists eventually trained at IRRI. Renewed in 1969, the program also included technology transfer activities.

Different projects were conducted with the collaborative efforts of IRRI and partner institutions in Sri Lanka, one of which is a collaboration with the country's Department of Agriculture (DOASL) and the United States Agency for International Aid (USAID). They undertook a Rice Research project where Sri Lankans were provided with nearly 25 graduate scholarships to different universities in the US, UK, and the Philippines, as well as 100 short-term trainings in rice production, and cropping systems. Moreover, the project also provided research equipment and infrastructure development in rice research stations, and included as a component the improvement of rice varieties.

In 2007, DOASL and IRRI held a collaborative workplan meeting where they identified some areas for mutual cooperation. This included improving existing rice varieties in terms of quality and yield, enhancing conservation of rice genetic resources, increasing labor productivity, and strengthening the delivery and impact of technology through good extension models. Similar with past agreements, DOASL continued to serve as the clearing house for IRRI's activities in Sri Lanka. Both institutions continue to find ways and means of improving collaboration including funding support.

RICE RESEARCH
AND
DEVELOPMENT INSTITUTE
Department of Agriculture - Sri Lanka

RICE CULTIVATION

RICE

Rice is the single most important crop occupying 34 percent (0.77 /million ha) of the total cultivated area in Sri Lanka. On average 560,000 ha are cultivated during maha and 310,000 ha during yala making the average annual extent sown with rice to about 870,000 ha. About 1.8 million farm families are engaged in paddy cultivation island-wide. Sri Lanka currently produces 2.7 million t of rough rice annually and satisfies around 95 percent of the domestic requirement. Rice provides 45% total calorie and 40% total protein requirement of an average Sri Lankan. The per capita consumption of rice fluctuates around 100 kg per year depending on the price of rice, bread and wheat flour.

The current cost of production of rough rice is Rs. 8.57 per kg. The cost of labor, farm power and tradable inputs constitutes 55%, 23% and 23% respectively.

Field water requirement for a rice crop depends mainly on the growth duration of the crop and its growing environment. It is calculated that about 30-40% of the total water supplied to an irrigated crop is often supplied before the establishment of the rice crop and the amount is dependent on the soil drainage class, weed density and time taken for land preparation. Time taken for land preparation could be minimised to about 2 weeks using total killing herbicides (e.g. Paraquat) which also would help to reduce one tillage operation and conserve irrigation water.

Recommended Herbicides for Rice Weeds
One shot herbicides

Trade Name	Common Name	Rate of application/ha
Sofit	Pretilachlor 300 g/lit.EC	1.6 lit.
Goal	Oxyflorfen 240 g/lit.EC	0.5 lit.

Broad leaves/Sedge Herbicide

Trade Name	Common name	Rate of application/ha
Hedonal	2.4 D 550 g/lit.SL	0.95 - 1.2 lit.
	MCPA 600 g/lit.SL/EC	0.8 - 1.1lit.

Source: http://www.doa.gov.lk/rrdi/index.php/en/rice

New Rathna Rice Mill
South Asia's Largest Rice Production Line

Head Office & Factory 01

New Rathna Rice (PVT) Ltd.
No. 54, Somawathiya Road,
Pulasthigama, Polonnaruwa,
Sri Lanka.
Tel - 027-2242627
Email - newrathna.rice@gmail.com

The Rice Grain

The rice grain has both physical and chemical characteristics.

Physical Structure

A rice grain is made up of an outside husk layer, a bran layer, and the endosperm, see Figure 1. The husk layer (lemma and palea) accounts for 20% of the weight of paddy and helps protect the grain kernel from insect and fungal attack. When the husk is removed, the rice is called brown rice. Brown rice contains the bran layer and the endosperm. The bran layer is made up of the pericarp and testa, the aluerone layer and the embryo. The degree to which this bran layer is removed is known as the milling degree. The desired amount of bran removed depends on the country. In Japan, the aluerone layer is often not removed however in many other countries all bran layers are removed to give very highly polished rice. The storage life of milled rice is improved when all of the bran layers are removed.

Physical characteristic	Percentage
Paddy	100
Husk	20
Brown rice	80
Meal Pericarp and testa (5-6%) Aluerone (1%) Embryo (3%)	8-10
White rice	70-72

Chemical Composition of Milled Rice

Rice at 12% moisture contains approximately 80% starch and 7% protein. (Currey, 198
Starch occurs in the endosperm as small many-sided granules while protein is present a
particles that lie between the starch granules. Rice grain also contains sugars, fat, dietar
fiber and minerals.

Component	Brown rice	White rice	Bran
Water (%)	13-14	13-14	13-14
Starch (%)	68-70	80	9
Amylose	28-30	33	6
Protein (%)	6-8	6-7	14
Fat	3	1	20
Fiber	2-3	0.5	25
Crude ash	1-1.5	0.5	9-10

Source: http://www.newrathnarice.com/

Araliya Rice Mill
3,2 ★★★★★ (4) · Industriegebiet
Polonnaruwa, Sri Lanka
+94 27 2 227227
Jetzt geschlossen
WEBSITE ROUTE

Chinthaka Rice Mill
5,0 ★★★★★ (3) · Lebensmittelanbieter
Sri Lanka
+94 71 446 2349
Jetzt geschlossen
ROUTE

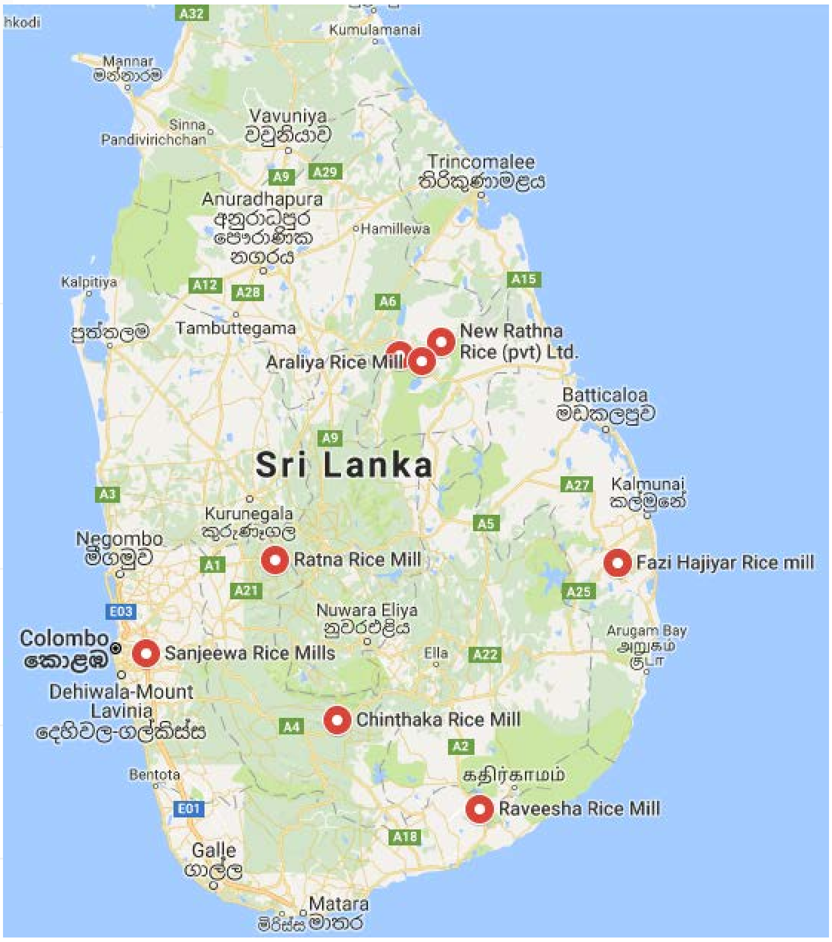
Fazi Hajiyar Rice mill
Keine Rezensionen · Reismühle
Sri Lanka
ROUTE

New Rathna Rice (pvt) Ltd.
4,7 ★★★★★ (3) · Mühle
Polonnaruwa, Sri Lanka
+94 27 2 242627
Jetzt geschlossen
WEBSITE ROUTE

Sanjeewa Rice Mills
4,3 ★★★★★ (3) · Lebensmittelanbieter
Malabe, Sri Lanka
+94 11 2 412703
Jetzt geschlossen
ROUTE

Raveesha Rice Mill
5,0 ★★★★★ (1) · Mühle
Sri Lanka
+94 71 566 0812
ROUTE

Ratna Rice Mill
Keine Rezensionen · Mühle
Mawanella, Sri Lanka
+94 35 2 246217
ROUTE



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Agricultural Water Management

Predicting the impacts of climate change—A case study of paddy irrigation water requirements in Sri Lanka

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ABSTRACT

Nearly 72% of paddy production, the staple food in Sri Lanka, is grown during the wet season in dry areas where water resources are already stressed. Climate change datasets for Sri Lanka were derived using outputs from the UK Hadley Centre for Climate Prediction and Research Model (HadCM3) for selected scenarios for the 2050s, chosen from the Intergovernmental Panel of Climate Change Special Emission Scenarios Report. Water balance modelling and a geographical information system were used to model and map the impacts on irrigation requirements for wet season paddy. We examined two scenarios. The A2 scenario represents a heterogeneous, regionalised, market-led world, with high population growth, leading to a rapid increase in atmospheric carbon dioxide levels. The B2 scenario follows a similar regionalised future but with more moderate population growth and more concern for the environment and local sustainability, and a slower rate of increase in atmospheric carbon dioxide.

Results suggests that, during the wet season, average rainfall decreases by 17% (A2) and 9% (B2), with rains ending earlier, and potential evapotranspiration increasing by 3.5% (A2) and 3% (B2). Consequently, the average paddy irrigation water requirement increases by 23% (A2) and 13% (B2).

Mapping with GIS highlights the importance of considering spatial variation. Climate change impacts on wet season paddy production are positive in the extreme south, confirming results of a previous study. However, the impacts are negative across most of Sri Lanka. The adaptations needed are different in the two regions. Furthermore, spatial variation points to a further adaptation; the transfer of some paddy production to positively affected areas, which would not have been so clear if only point modelling had been used.

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