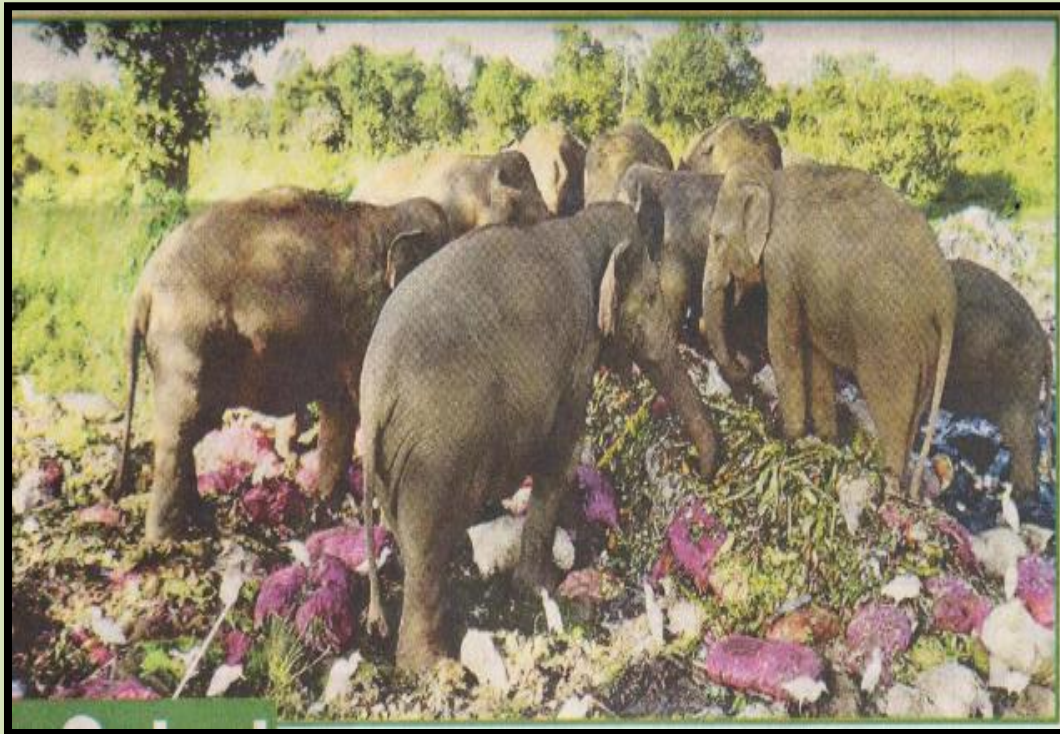




## **Food Waste at Dambulla Economic Center**



Project

# **Energy Efficiency and Renewable Energy Potential in the Food value Chain**

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# Introduction

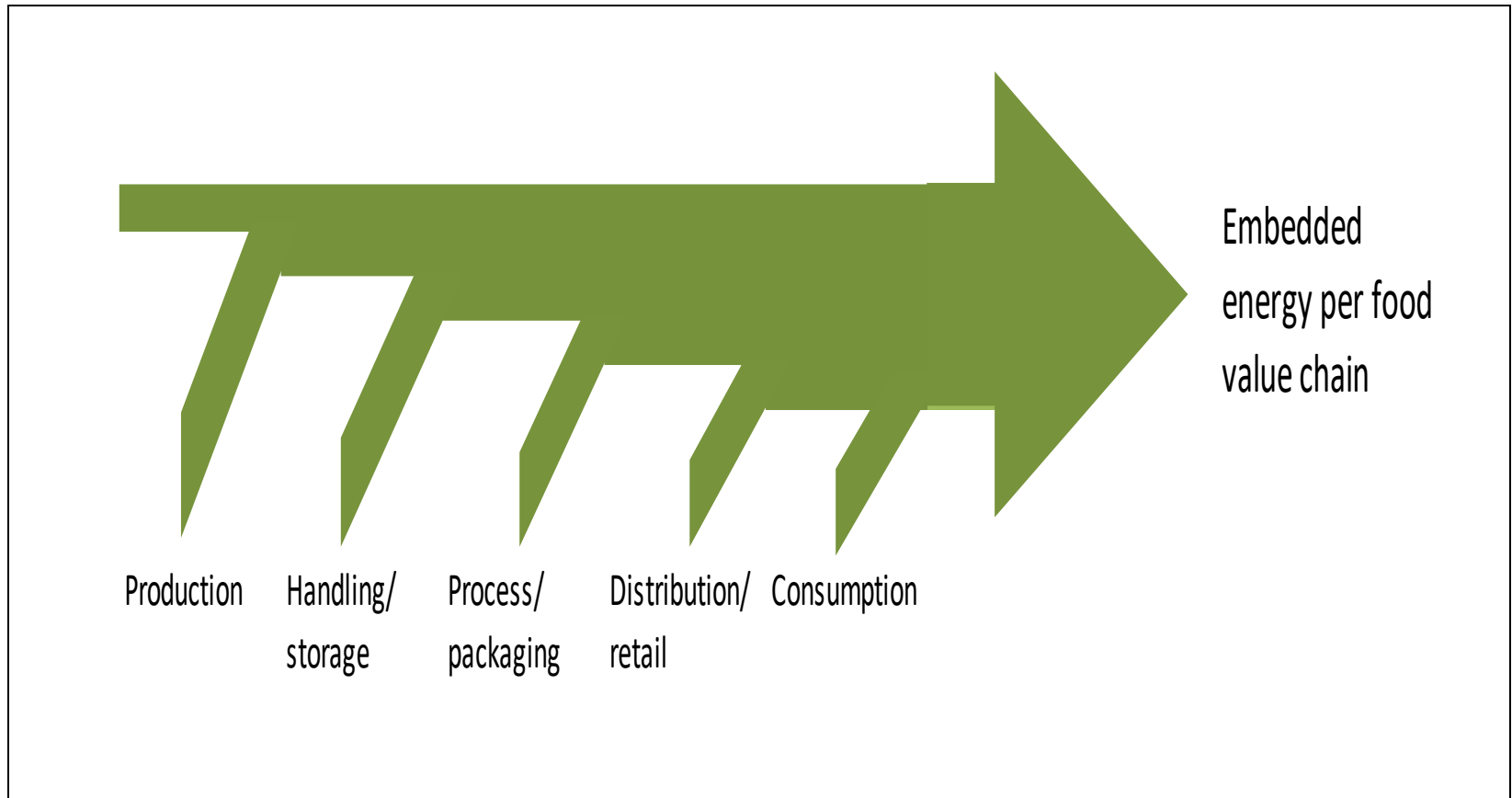
- Food value chain



- Stages

- Production, Handling & storage, Process & packaging, Distribution & marketing, Consumption

- Energy is accumulated in the food item at all steps across the food value chain



Accumulation of embedded energy

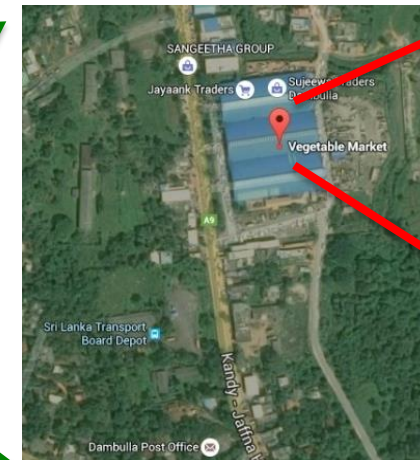
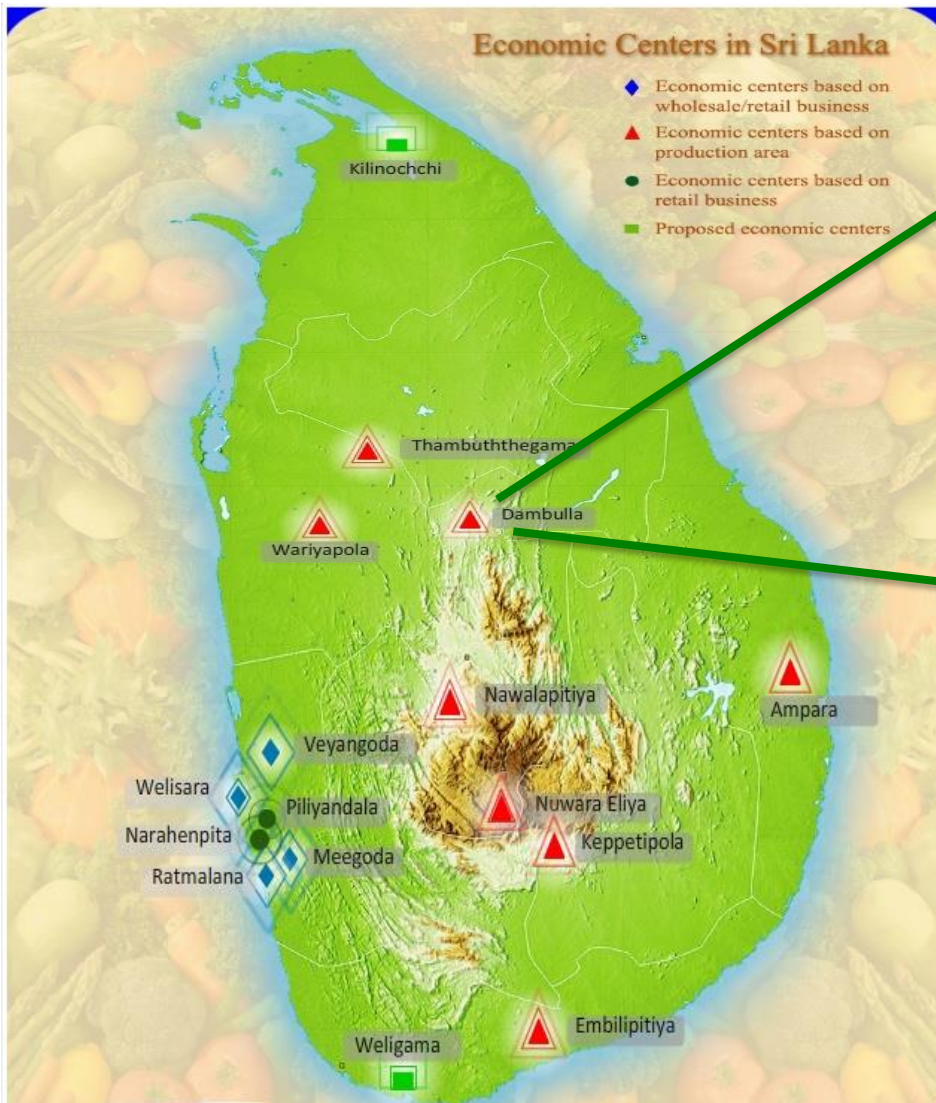
# Fruits and vegetables

- 80 different varieties of F & V are grown in varied agro-climatic areas in Sri Lanka
- Annual Production
  - Vegetables: 710,000 MT
  - Fruits: 540,000 MT (Industry Capability Report, 2013)
- Contributed 4.2% for the national GDP



# Dambulla Economic Center

One of the seventeen economic centers in Sri Lanka



6 Blocks

144 stalls

Vegetable stalls	- 116
Fruit stalls	- 03
dry fish stalls	- 06
Grocery	- 20
Restaurants	- 09

## Project : To resolve following problems..

- Non availability of economical waste management measures at Economic Center, Dambulla
- Lack of reliable statistics on average losses in different fruits and vegetables at Economic Center, Dambulla
- Limitations in curtailment measures to assess the post-harvest losses of fruits and vegetables throughout the market chain
- Difficulties on evaluation of energy levels and identify root causes for post-harvest losses in fruit and vegetable market chain in Sri Lanka

# Methodology

- Estimation of food volumes in terms of inward bound, outward bound and waste generated including waste disposal, at the Economic Centre
- Quantification of embedded energy of the food value chain for three selected fruit/vegetable/leafy items
- Quantification of the total food wastage at the Economic Centre through a sample segmentation approach
- Trace the supply chain from farm to the household and quantify waste generation and embedded energy
- Estimation of energy impact in different packaging / preservation methods, in the perspective of reduced waste (utilization avenues)



# Quantification of daily volume of F & V transaction and wastage at DEC

## Personal Interview method

From Management, Whole sellers, Laborers  
18 months period

No of vehicles  
coming per day

No of vehicle load  
of waste per day

Mean daily transaction volume of  
F & V at DEC

= (No of vehicles coming per day \*  
Average weight of the vehicle load)

Mean daily wastage at DEC  
= (No of vehicle load of waste per  
day \* Average weight of the  
vehicle load)

# Determination of bio gas generation potential from the waste at DEC

Amount of daily waste at DEC  
(tones)



**Assumption**  
Digester can yield  
From 1 tone of food waste =  $20 \text{ m}^3$  of bio gas



**Calculation**  
Amount of Biogas ( $\text{m}^3$ )  
= food waste (tone) x yield of digester ( $20\text{m}^3/\text{tone}$ )

# Assessing the F & V losses at stall

Questionnaire based survey

Twice a month for 18 months

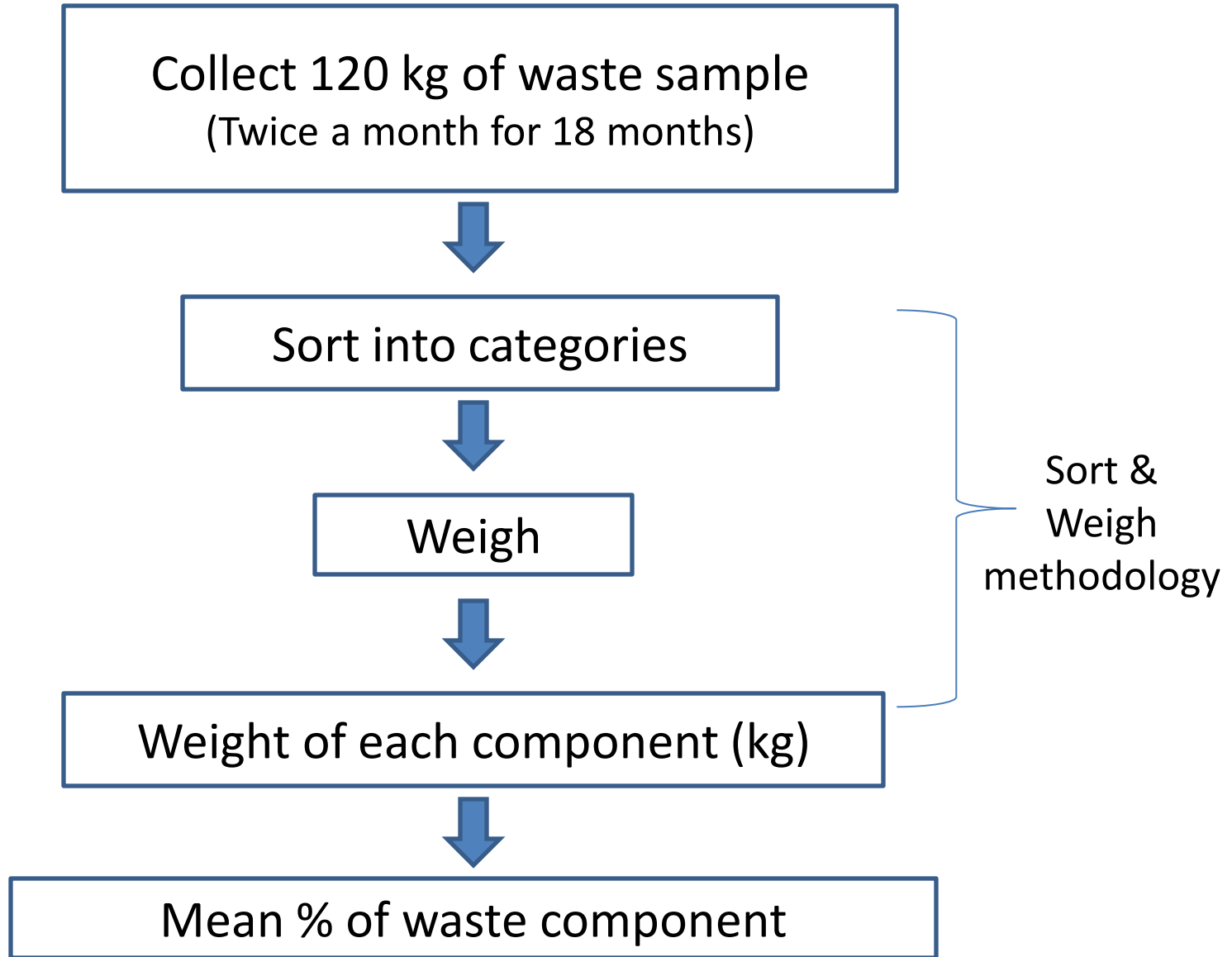


Incoming volumes and  
loss per day



Mean % loss of F & V at a stall

# Waste segmentation



# Identification of root causes for losses of fruits and vegetables at DEC

Collect waste component  
(sorted through sort & weigh methodology)



Visual Observation



Identify the cause for losses



% Weight of losses due to  
different causes



# Assessing the losses of selected vegetables through value chain

Questionnaire based  
survey



At Whole seller, retailer &  
consumer level



% loss of selected crop at  
whole seller, retailer and  
consumer level

# Assessing the losses of selected vegetables through value chain

Questionnaire based  
survey



At Whole seller, retailer &  
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% loss of selected crop at  
whole seller, retailer and  
consumer level

# Estimation of embedded energy through value chain

Questionnaire based survey



Fuel usage at each node



Energy = Amount of Fuel(L)\*Caloric value of Fuel (KJ/L)



Energy calculation

Energy use at each node = 
$$\frac{\sum \text{energy content in fuel}}{\text{Quantity produced} - \text{waste}}$$

# Identification of suitable packaging/ preservation/utilization methods

Composite waste



Extraction of pectin  
(Method :Koubala *et al.*, 2008)



$$\text{Yield of Pectin (\%)} = \left( \frac{\text{Weight of dried pectin}}{\text{Weight of the sample taken for extraction}} \right) \times 100\%$$

# Results



## Daily volume of Fruit and Vegetables at DEC

Mean number of vehicle load of fruits and vegetables at DEC  
= 1900/day

Average weight of the vehicle loads  
= 1800 kg

The daily waste at DEC  
= 1900\*1800 kg  
= 3,420,000 kg

(3420 metric tons)

## Daily wastage at DEC

Mean number of vehicle load of waste at DEC  
= 06/day

Average weight of the vehicle loads  
= 1800 kg

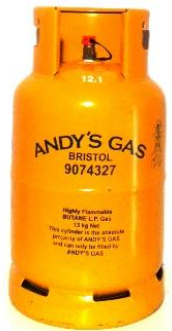
The daily waste at DEC  
= 6\*1800 kg  
= 10800 kg

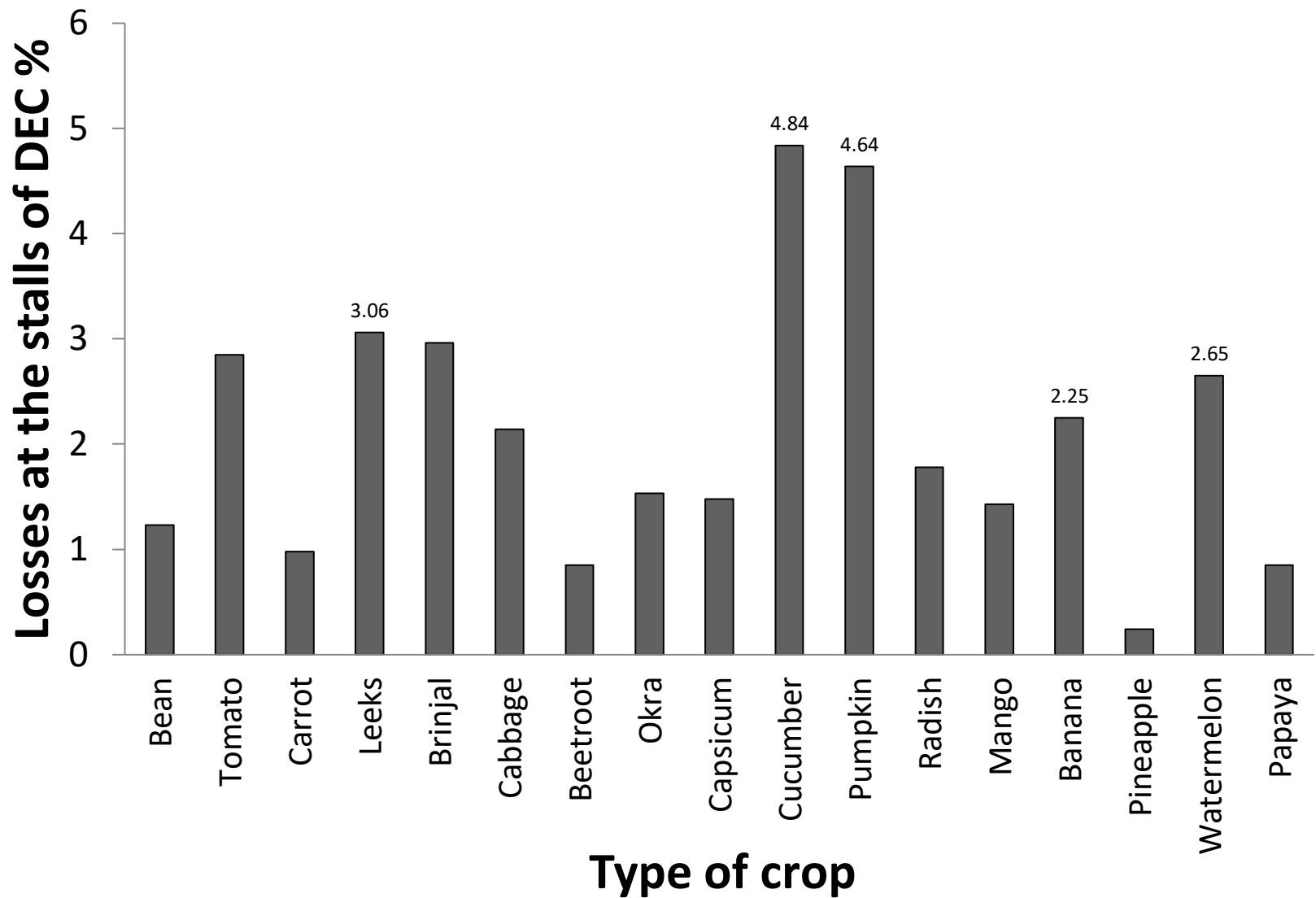
(10.8 metric tons)

# Bio gas generation potential from the waste at DEC

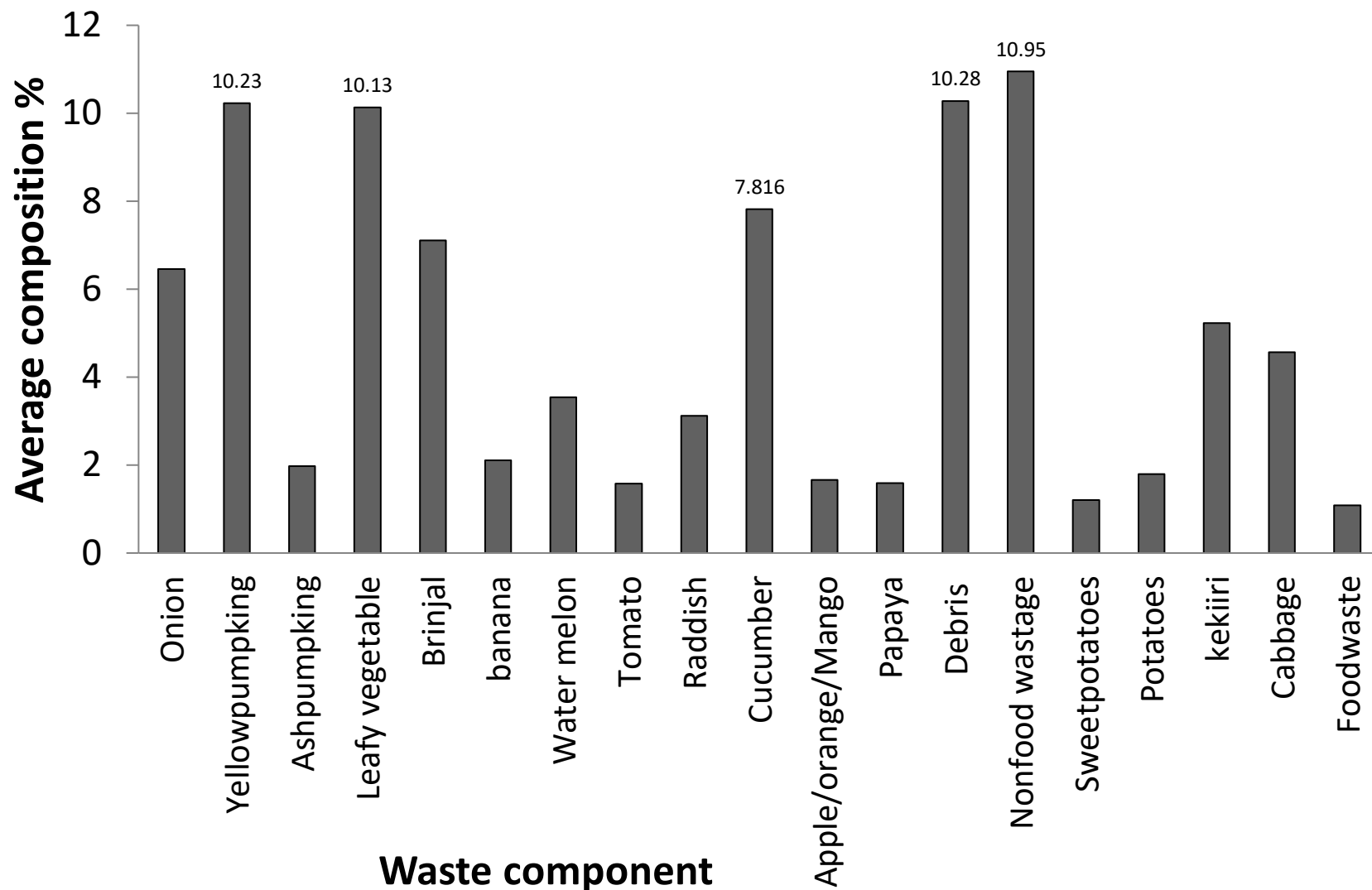
Amount of waste (tone)		Yield of the digester (m <sup>3</sup> /tone)
	↘	↘
Amount of Biogas (m <sup>3</sup> )	=	10.8*20
		= 216 m <sup>3</sup>

Equal to sixteen (16) number of 13.5 LP gas cylinders

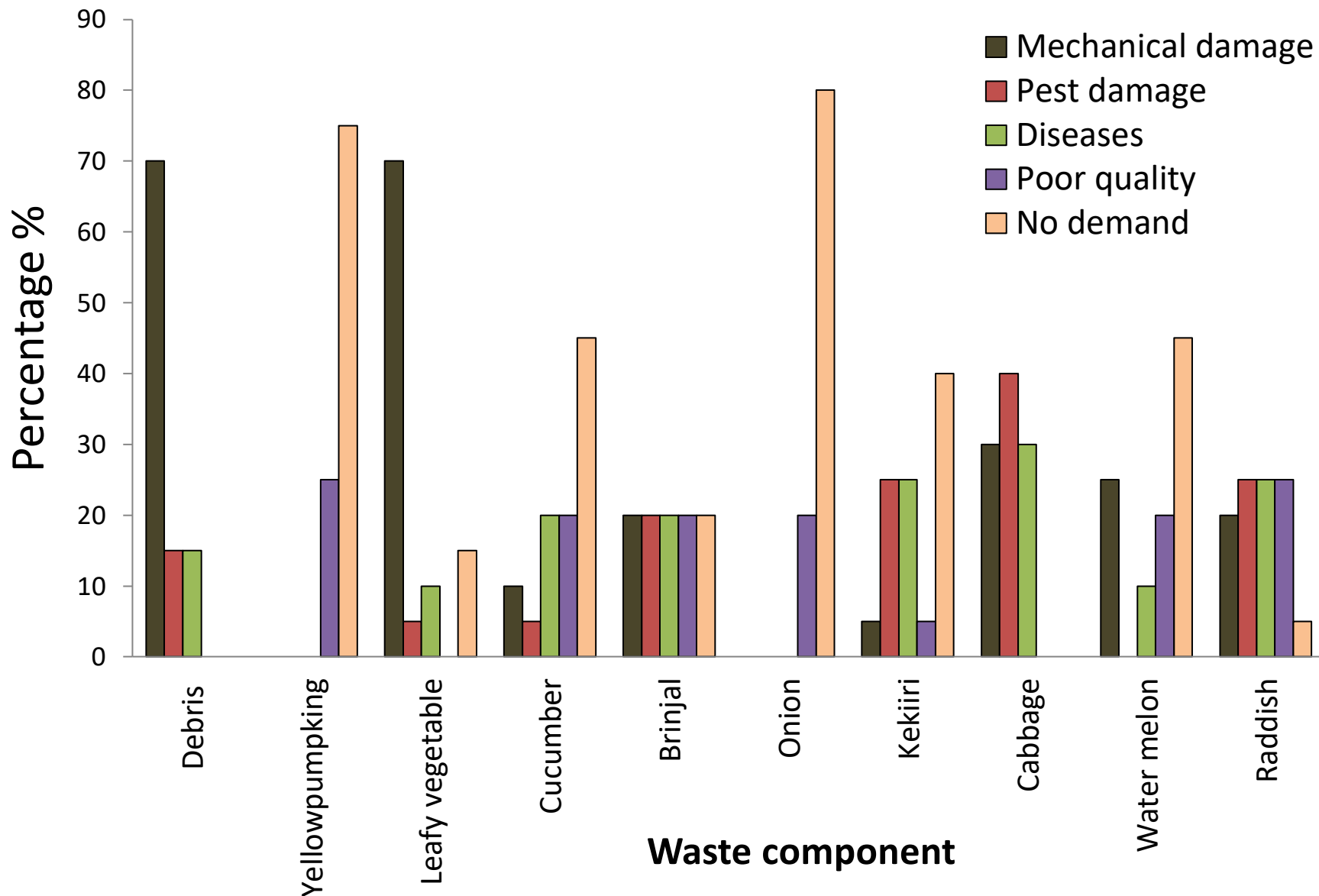




## Fruits and vegetable losses at the stalls of Dambulla Economic Center



**Composition of the main waste components at the Dambulla Economic Center**



**Root causes for the losses of main fruits and vegetables waste components at DEC**



# Root causes for the losses at DEC

1. No demand (30.28%)
2. Pest damage (19.42%)
3. Diseases (18.14%)
4. Mechanical damage (16.71%)
5. Poor quality (15.42%)



# Proximate analysis of waste

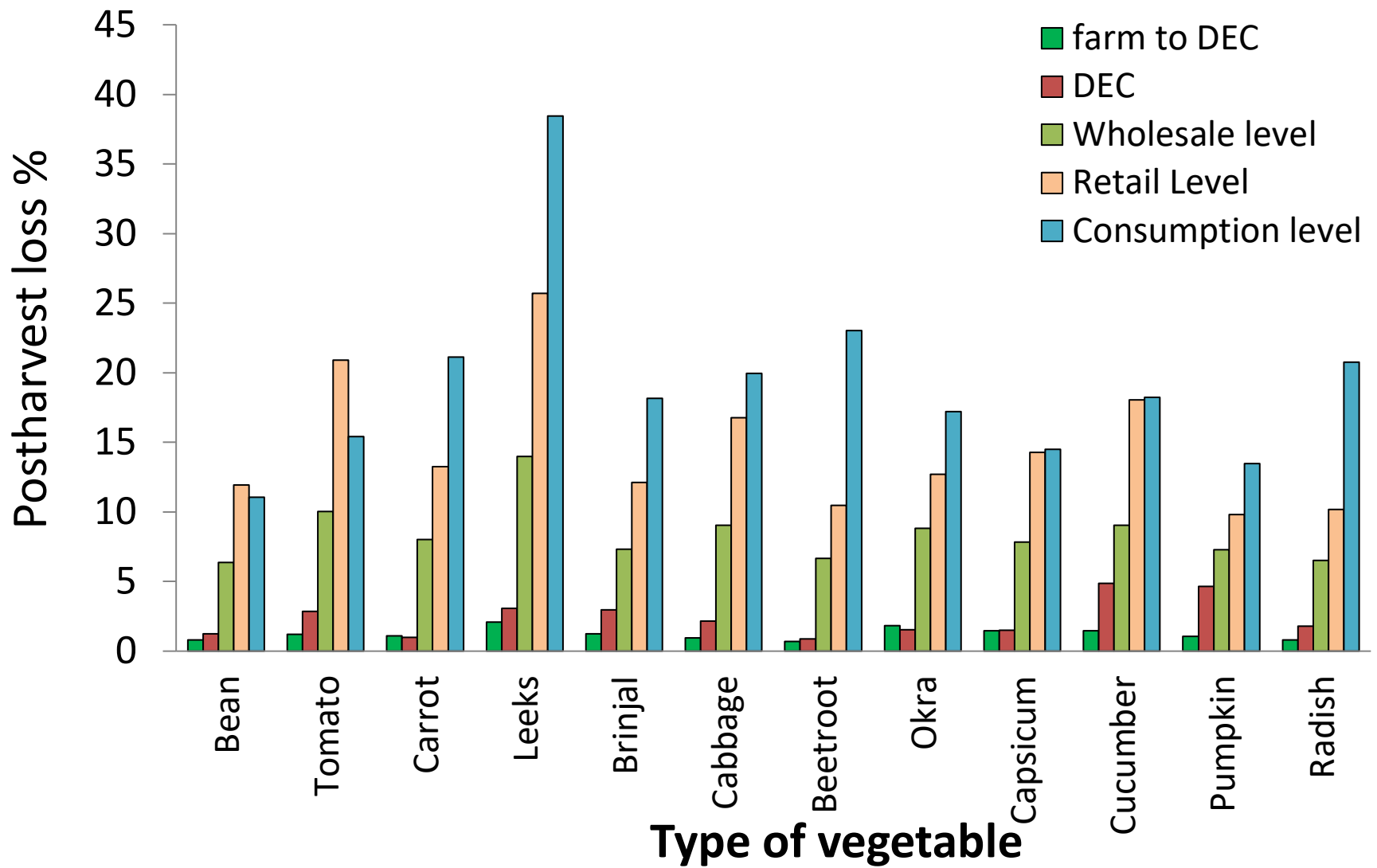
- Moisture content - Oven dry method (AOAC, 1996)

$84.59 \pm 1.94 \%$

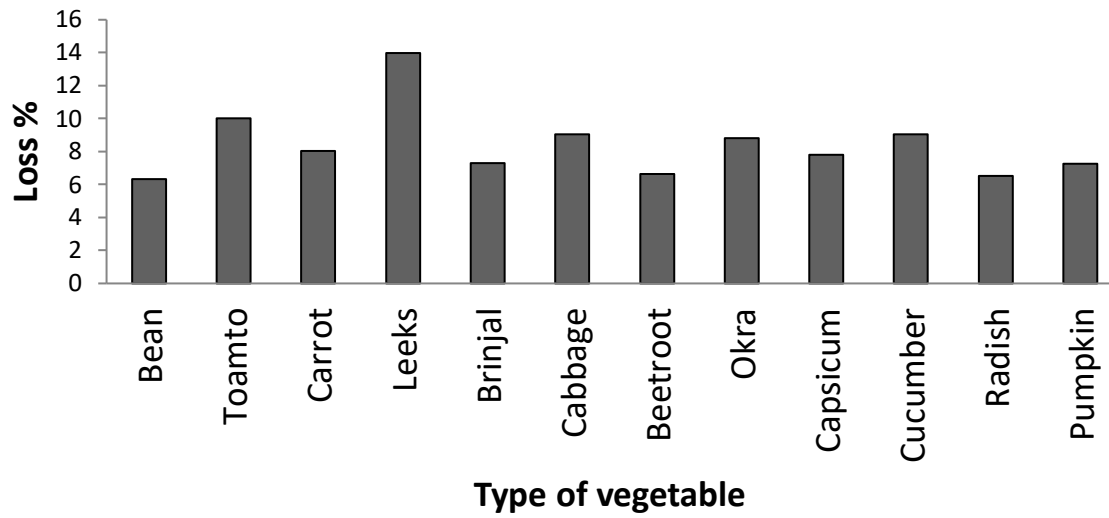
- Ash content - Gravimetric method (AOAC, 1996)

$6.60 \pm 0.04 \%$

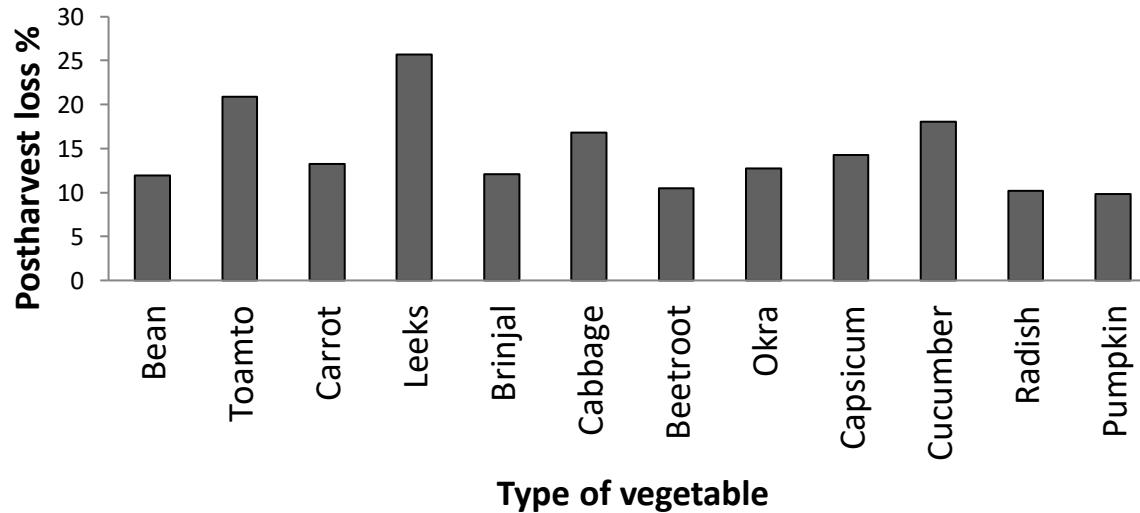
There is a possibility to produce bio gas from waste at DEC



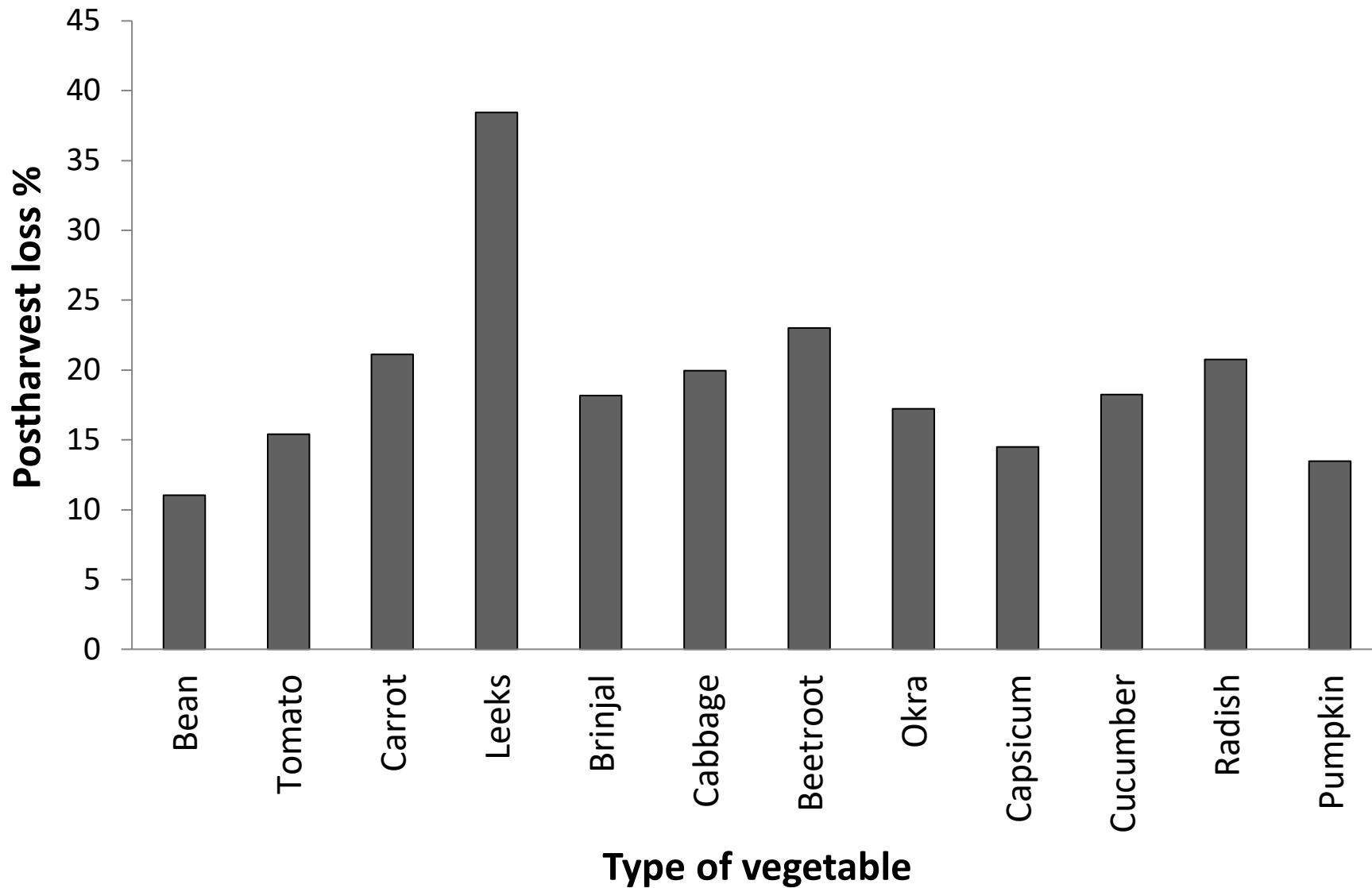
**Postharvest losses of the selected vegetables through the value chain**



## Postharvest losses at wholesale level



## Postharvest losses at retail level

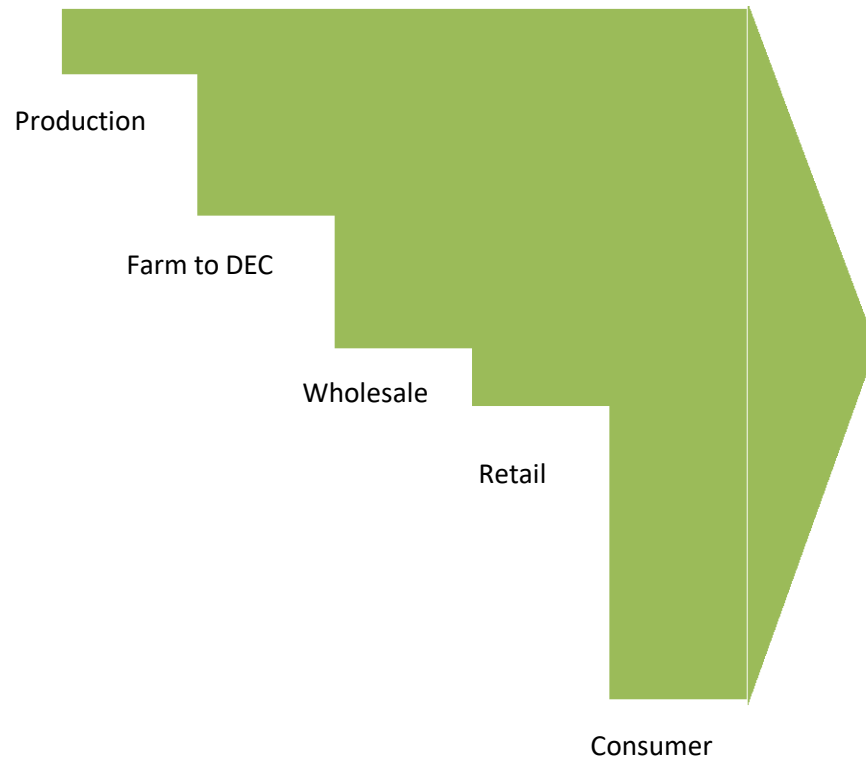


## Postharvest losses at consumer level

# Embedded energy through value chain (kJ/kg)

Crop \ Stage	Bean	Tomato	Carrot	Leeks	Brinjal	Cabbage	Beetroot	Okra	Capsicum	Cucumber	Pumpkin	Radish
Production	490	522	565	403	398	358	492	377	348	445	328	287
Distribution (Farm to DEC)	1006	802	1023	999	418	636	932	485	688	510	511	814
Wholesale	943	981	960	1026	946	971	946	961	951	962	945	944
Retail	438	488	445	520	439	467	431	442	450	471	428	430
Consumer	2062	2026	2271	1890	2620	2742	2256	2094	1991	2642	4583	2247

# Illustration of accumulation of embedded energy through the value chain



# Embedded energy of vegetables through value chain



Bean



Tomato



Carrot



Leeks



Brinjal



Cabbage



Beetroot



Okra



Capsicum



Cucumber



Pumpkin



Radish



# Pectin Extraction

Whole pumpkin

Core

Peel

Yield

$2.27 \pm 0.02 \%$ ,

$2.51 \pm 0.21 \%$

$2.90 \pm 0.06 \%$



Pineapple Jam

Composite waste sample of F & V at DEC yielded,  
 $2.36 \pm 0.25\%$  pectin

# Conclusions

- The total estimated amount of daily waste at DEC 10,800 kilograms per day
- The potential to generate biogas from waste generated at DEC 216 m<sup>3</sup> of biogas per day = 16 (13.5 kg) gas cylinders
- The maximum proportion of the waste include Non food wastage, Debris of fruits and vegetable, Pumpkin, leafy vegetables, Cucumber
- The identified root causes for the waste were no demand, pest damage, diseases, mechanical damage and poor quality
- Embedded energy increases along the value chain with different proportions for different crops
- Pectin can be extracted from fruits and vegetable waste ~ 2.5% (dry basis)

## To reduce the post harvest loss of F & V..

- Training of Producer
  - Appropriate use of fertilizers and pesticides, marketing and production planning methods
- Invest in Infrastructure:
  - Transport, Storage
- Promote simple Post-harvest technologies:
  - Improve packaging, provide shade, control pests
- Improve access to high quality seeds and other inputs
- Training traders on effective and efficient transport or storage practices

# Suggestions

- Application of cleaner production methodology to reduce postharvest losses of vegetables
- Application of cold chambers for the transportation of fruits and vegetables



Thank You