Assessments of Forestry Biomass Availability

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Summary of Methods of Field Assessments of Forest Residue remaining after Harvesting (TUP = Temporary Unplanted)

A) Physical weighing of biomass in plots laid out in TUP

B) Transects across TUP (Zig-Zag transect method)

C) Allometric ratios (Desktop study)

A) Weighing of Biomass to determine tons/ha

1. Decide which form of biomass is to be measured (slash or stumps or branches or all residue on site)

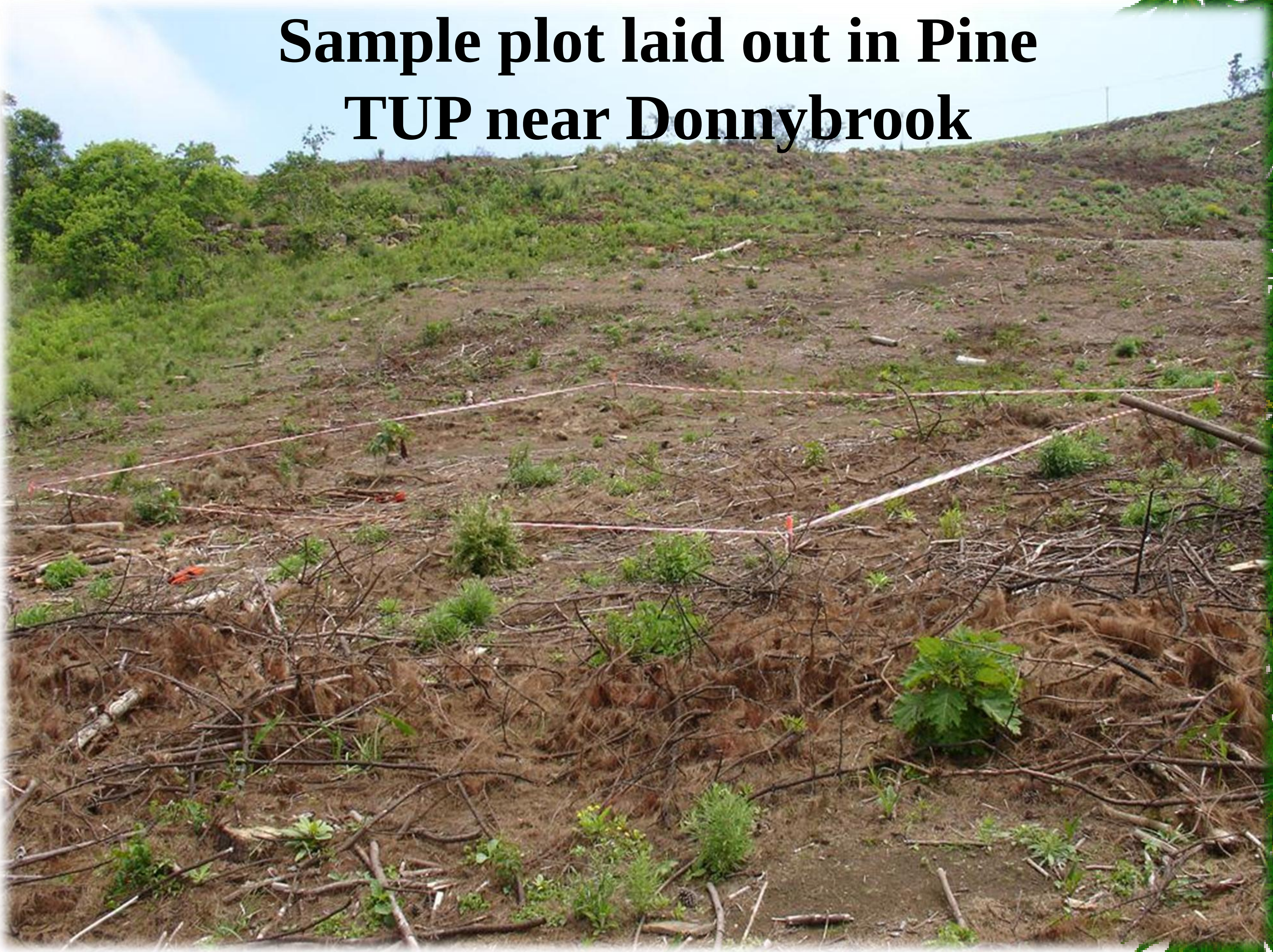
2. Determine size parameters of biomass

3. Lay out sample plots on random basis

4. Weigh all biomass within plot boundary

5. Scale up results to determine mass per ha

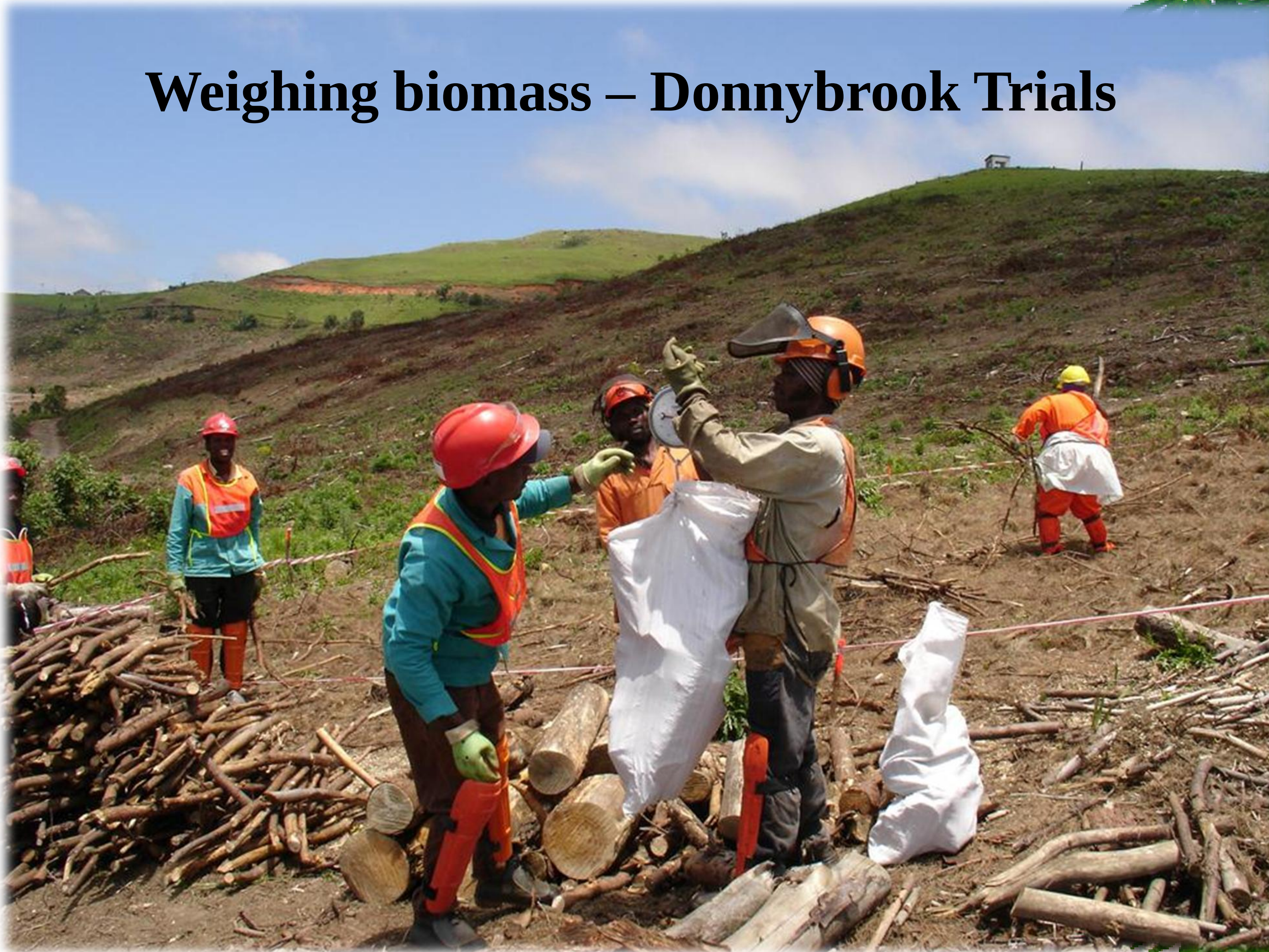
Sample plot laid out in Pine TUP near Donnybrook



Sorting biomass in size classes for weighing – Donnybrook trial

Pine biomass loaded onto tractor for weighing – Zululand Trials

Weighing biomass – Donnybrook Trials



Weighing biomass at Sokhulu Weighbridge - Zululand

Scale up results from trial plots to obtain volume or tons/ha of biomass.

Eg : 800 m2 plot (RC 24, Mondi Zululand) of Harvesting Slash yields 700 kg biomass, thus 0.88 kg/m2 x 10 000 m2 (1 ha)

= 8800 kg or 8.8 tons/ha (*potential biomass*)

Some results obtained weighing the following categories of biomass in a trial in Zululand:

1. **Final coppice reduction stems**
2. **Stumps from 2nd rotation coppice crop**
3. **Old growth stumps – multiple rotations**
4. **Harvesting slash (all utilizable timber removed)**

Compartment RF 10 (Final coppice reduction stems)

Plot size	**9000 m2**
Duration of trial	**2 days**
Number labour units	**16**
Weight of biomass removed	**2937 kg**
Weight of biomass/ha	**3300 kg**
Cost in R/ton (2005)	**R229.64**

(cost of extraction and haulage 10 km to weighbridge)

Compartment RC 25 – 2nd rotation coppice stumps

Plot size	**10 000 m2**
Duration of trial	**2 days**
Number labour units	**10**
Weight of biomass removed	**11 500 kg**
Weight of biomass/ha	**11 500 kg**
Cost in R/ton (2005)	**R72.51/ton**

(cost of extraction and haulage 10 km to weighbridge)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Compartment RC 24 – old growth stumps

Plot size	**800 m2**
Duration of trial	**0.5 days**
Number of labour units	**5**
Weight of biomass removed	**2520 kg**
Weight of biomass/ha	**31500 kg**
Cost in R/ton (2005)	**R108.58**

(cost of extraction and haulage 10 km to weighbridge)

Compartment RC 24 – Harvesting Slash (no utilizable timber)

Plot size	**800 m2**
Duration of trial	**0.5 days**
Number of labour units	**5**
Weight of biomass removed	**700 kg**
Weight of biomass/ha	**8800 kg**
Cost in R/ton (2005)	**R327.03**

(cost of extraction and haulage 10 km to weighbridge)

Advantages and disadvantages of manual weighing of biomass

Advantages

- Accurate results

Disadvantages

- Plot location critical, difficult to obtain objectivity
- Time consuming
- Very expensive
- Unsuitable for macro scale estimations

B) <u>Zig-Zag Transects</u>

Also known as Line Intersect Sampling (LIS) whereby volume of wood per unit area is estimated based on diameter of logs within pre-determined set of length and diameter parameters intersected by line of known length.

Zig-Zag LIS was found to be as accurate and precise as various other methods of waste sampling and was only system to show no significant bias *(LIRO, New Zealand, Project Report 60, 1996)*

One forestry company adapted this method whereby 20 transects of 20 m length are laid out at 45 deg to each other at random throughout comp to be measured *(parameters = minimum utilizable log size)*

One can adapt parameters for biomass estimations:

E.g. – diameter $\geq$3.0 cm, length $\geq$ 30 cm

All material equal or exceeding these parameters are recorded on a field sheet, only diameter at point of line intersect is recorded

Sum of diameters are squared and divided by factor (20.273) to obtain m3/plot.

Mathematical average of 20 plots = biomass in m3/ha

Biomass Infield Sample Forms:

Date: 24/11/2006 | **Sirex:** Yes

Comp: D14 | **MAI:** 23.9

Species: P.patula | **Tons/ha @ clearfell:** 385 ??????

Plantation: Mondi Shanduka: Donnybrook | **Biomass/ha:** 15.40 m3/ha

DBH 2

Plot No	Dbh	Dbh	Dbh	Dbh	Dbh	Dbh	Dbh	Dbh	Dbh	Dbh	Sum Dbh2	M3
1	132										132	6.52
2	213										213	10.5
3	0										0	0
4	88.4										88.4	4.36
5	0										0	0
6	0										0	0
7	0										0	0
8	121	88.4	62.4	306	121						699	34.5
9	196										196	9.67
10	119										119	5.86
11	149	60.8									210	10.3
12	49	121									170	8.39
13	56.3	640									696	34.3
14	130										130	6.41
15	56.3	81	82.8								220	10.9
16	0										0	0
17	64	1024	144								1232	60.8
18	1037	149	676								1862	91.8
19	110	49	119								278	13.7
20	0										0	0
Total										Ave.	312	15.4

Parameters: All timber measured at point of intersection with dia >7.0 cm and length >1.0 m

Transects are 20 m long and laid out at 45 degree zig-zag pattern across compartment

Factor = 20.273 - take sum of dia per plot, square it and divide by factor to get m3 per plot

Advantages and disadvantages of Zig-Zag LIS sampling

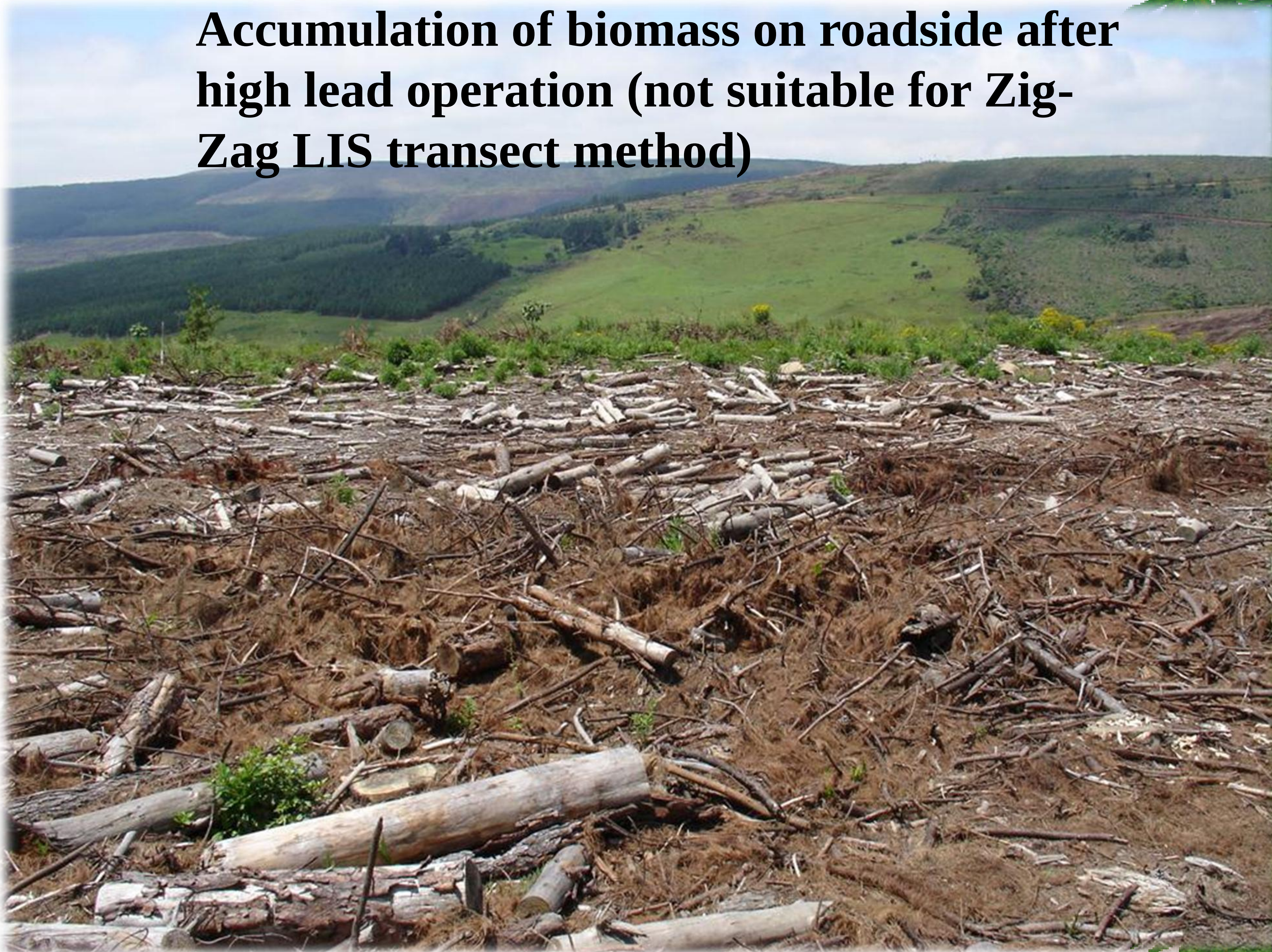
Advantages

- Relatively accurate (if state of TUP is suitable)
- Cheaper and less time consuming than manual weighing

Disadvantages

- Element of subjectivity with transect layouts
- Not suitable for tree length harvesting with accumulations of biomass on roadside

Accumulation of biomass on roadside after high lead operation (not suitable for Zig-Zag LIS transect method)



Broadcast slash after mechanical harvesting – Mtunzini (very suitable for Zig-Zag LIS transect sampling)

C) Allometric Ratios: (ICFR Bulletin 13/2005)

Can be used to convert standing m3 (original crop) into:

1. **Oven-dry stem wood in tons/ha (x m3 by 0.45)***
2. **Oven dry bark in tons/ha (x stem wood tons/ha by 0.12)***
3. **Oven dry branches in tons/ha (x stem wood tons/ha by 0.12)***

*** Factor for *E.grandis***

Ratios to convert Timber Volume to dry mass (ICFR Bulletin Series: No 13/2005)

	INPUT ONLY			POTENTIAL BIOMASS
Species	Utilizable Timber Volume (m3/ha)	Oven Dry Stem Wood(t/ha)	Oven Dry Bark (t/ha)	Oven Dry Branches (t/ha)
A.mearnsii	150	98.1	12.753	25.506
E.dunnii	150	80.4	12.864	9.648
E.grandis	150	67.5	8.1	8.1
E.macarthurii	150	82.65	12.3975	17.3565
E.nitens	150	78.9	9.468	26.826
E.smithii	150	87.15	8.715	18.3015
P.patula	150	58.05	5.2245	15.093

Notes:

1 Utilizable timber volume = ave m3/tree * Spha.
Biomass = branches in oven dry tons/ha (no stem material > 5.0 cm dia), no bark or leaves.

Variance Analysis: (case scenario) Allometric vs. Zig-Zag LIS

- **Allometric Ratio = 12.8 t/ha**
- **Zig-Zag LIS = 11.07 t/ha**
- **% variance = 15.6.**
- **Trend confirmed by ICFR**
- **Allometric ratios for *E.gra* obtained from data from 21 different sites.**
- **Greater objectivity than Zig-Zag LIS transects which have more variables (siting of transects, harvesting methods, accessibility of pieces etc).**
- **Dr. Colin Smith in favor of Allometric Ratio method to determine biomass in harvesting residue, pending further research.**

Advantages and disadvantages of Allometric Ratios

<u>Advantages</u>

- **Quick and cheap to implement**
- **Scientific basis for evaluation**
- **Suitable for macro studies on desktop basis**
- **Greater subjectivity than other methods**

<u>Disadvantages</u>

- **Gives indication of *potential* biomass only**

Common denominator about all 3 methods of biomass estimations:

<u>Only supply an estimate of POTENTIAL biomass</u>

No indication of actual available biomass as a tangible product or raw material from the forest.

There is a need for a sampling method which would indicate in tons or m3/ha, the actual available biomass as a utilizable product from a particular site and or/genus.

Case study – Sugar Estate in Malawi

Needed to get a handle on volume and cost of production of available biomass from cane trash for co-generation at the Mill to reduce electricity dependence and expense.

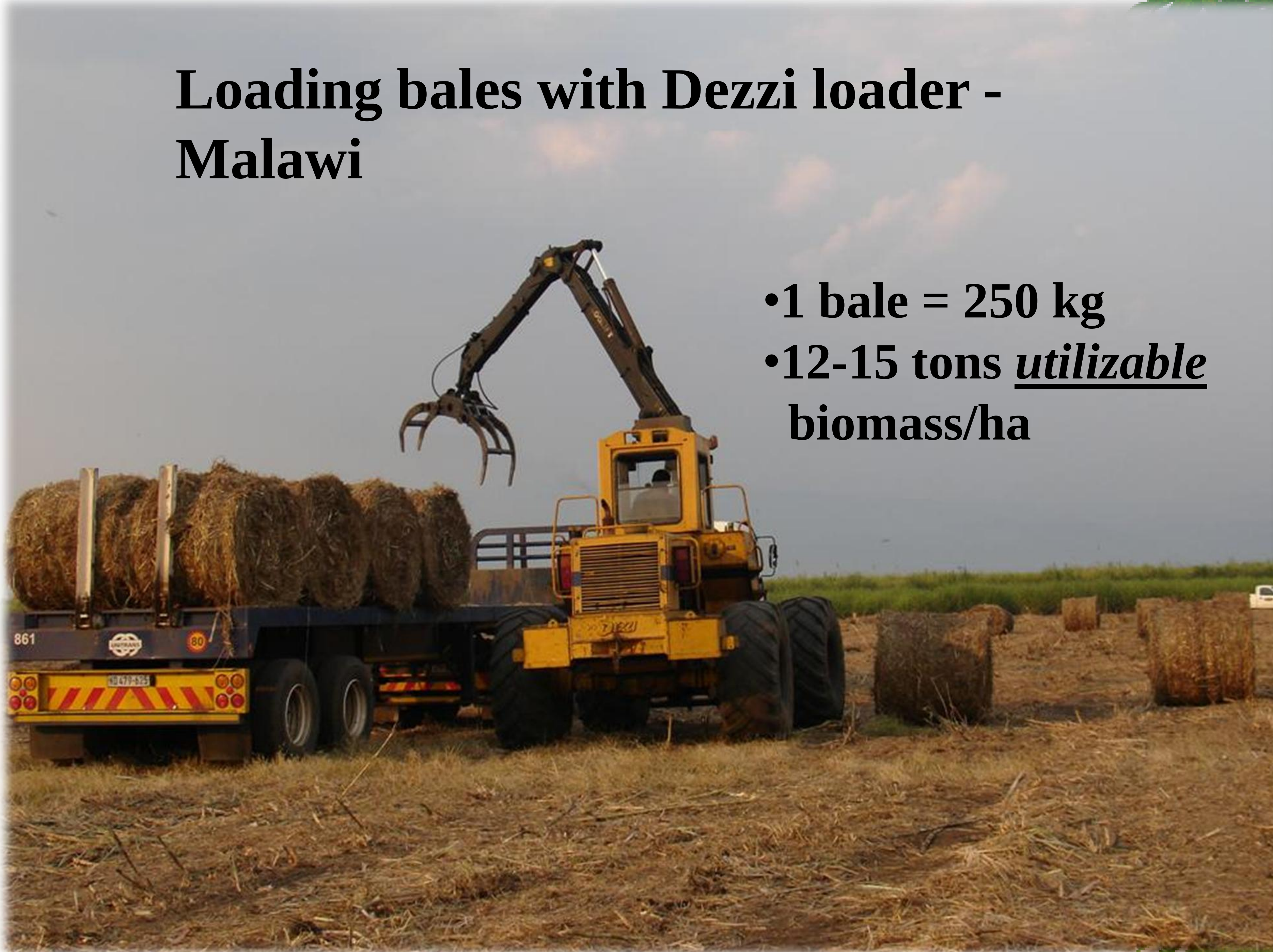
System was developed specifically for this end:

1. **Windrow cane trash after chopper harvesters**
2. **Bale cane trash with agricultural balers**
3. **Load bales and transport to Mill**
4. **Grind up bales through tub grinder as feedstock for steam turbine**
5. **Outputs are steam and electricity**
6. **Each element of the process is measurable, thus productivity and costs can be determined**

Windrowing cane trash for baling – Malawi

Baling of windrowed cane trash - Malawi

Loading bales with Dezzi loader - Malawi



- 1 bale = 250 kg
- 12-15 tons ***utilizable*** biomass/ha

There is a need for the development of a method of assessment of infield biomass volumes as a utilizable, value added product, either in bales, chips or any form that can be extracted and transported relatively easily to the processing plant – then one can assign a value to forestry residue (biomass) as just another product in the value chain.

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