Economic appraisal of woodchip use

Report 8

Woodchip for Livestock Bedding

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FARMING connect
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HYBU CIG CYMRU
MEAT PROMOTION WALES

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Mae'r Prosiect Sglodion Pren ar gyfer Sarnau Da Byw a gyflenwir gan Hybu Cig Cymru yn derbyn arian cyfatebol gan y Comisiwn Coedwigaeth, Asiantaeth yr Amgylchedd Cymru a Llywodraeth Cynulliad Cymru fel rhan o Cyswllt Ffermio.

1. Introduction

Reports 4 and 6 have so far examined the nutrient dynamics which occurred during the composting of woodchip-derived manure (WM), which had previously been used for animal bedding, and the subsequent agronomic benefit of WM compost in a range of agricultural contexts. This report specifically assesses the economic viability of woodchip use in a range of agronomic contexts. Due to the diversity of individual farming practices throughout Wales (e.g. farm size, livestock type, geographical location, infrastructure, proximity to suppliers etc), we have tried to approach the economic analysis from a broad perspective. We have used case study examples to demonstrate different potential scenarios involving woodchip use on farm. Unless prices are stated as quotes, they should be viewed as guides. Every effort has been made to provide the greatest number of farmers with an accurate and realistic assessment of using woodchip bedding under current market conditions.

2. Scenarios

The scenarios in this report are based on two fundamental facts; 80% of Welsh, agricultural land is categorised as Less Favoured Area (LFA) and the national average holding is 40 ha (see Table 1). Under Tir Gofal, a maximum of 72, Dairy, Suckler or Beef cattle over 24 months **or** 480 breeding ewes (with or without lambs) are permitted on a 40 ha holding within a Disadvantaged Area. Beef cattle under 24 months were not used in these scenarios. The permitted number of livestock increases proportionately to 360 mature cattle or 2,400 breeding ewes on 200 ha.
In order to standardise the scenarios, a hypothetical set of parameters were developed;

1. Cattle are housed for 16 weeks and sheep for 8 weeks.

2. Bedding application rates for both livestock types are as follows; an initial 10 cm base layer followed by a 5 cm top-up layer each week throughout the respective housing periods. If woodchip is bought by weight, then moisture loss must be accounted for in the weight purchased. For example, 94.91 t of woodchip with 50% moisture content (mc) fills the same volume (306 m^3) as 86.68 t at 30% mc.

'Green' or 'recently felled' wood contains 45–60% moisture, depending on the tree species and season.

3. All purchased woodchip, waste wood or round timber is assumed to have a 50% mc, so must be stored either chipped or unchipped, until the woodchip is less than (<) 30% mc, as recommended in reports 1 and 2.

4. The chipper model used in all the scenarios is a 6 year old, ex-trade, Laimet HP 25. To hire a similar model costs £100 for 1 day and £50/day thereafter, 5 days hire is discounted to £50 everyday.

In this report, woodchip has a green volume to weight ratio of 3.224 m^3/t (including a 60:40, air to wood ratio) and costs £60/t, although prices vary considerably depending on location, season, wood type, moisture content and not least, fossil fuel prices at the time of purchase. Green softwood timber has a volume to weight ratio of 1.29 m^3/t and hardwoods 0.9-1.1 m^3/t approx. The current market price of 'short round wood' suitable for chipping is £15/t approx. Waste wood products cost £2–4/t, but may be surcharged if screening for metal fragments is needed before delivery (e.g. broken pallets). Treated waste wood products are not suitable for woodchip bedding, as they may contain levels of copper, chromium and arsenic (CCA), creosote, light organic solvent preservatives (LOSP), micro emulsions, paints and varnishes. Farmers should ensure that any

waste wood deliveries contain no treated materials before arrival. If farmers choose to buy a Laimet chipper, it is recommended that timber and waste wood is chipped green, because dry wood (particularly spruce) will quickly blunt the blade and dramatically increase the chipper's maintenance costs. Another word of caution, farmers must not under-estimate to the area of covered space required to dry or store woodchip. When drying woodchip to reduce its moisture content, the heaps should not be more than (>) 1 m high, to avoid fungal growth and when dried to < 30% mc, ideally heaps should still not exceed 2 m. A simple method can be used to calculate the space required for drying and then storing woodchips. For example, take the scenario above where a farmer has 480 ewes and will house them for 8 weeks at a density of 1.33 m^2/head, (480 × 1.33) is multiplied by the total depth (m) of woodchip that will be applied over the 8 weeks, (480 × 1.33) × 0.45 = 287 m^3. The area (m^2) required to dry this volume of woodchip is √287 = 17 × 17 m and the area (m^2) required to store the woodchip in 2 m heaps once it's dried is, √ (287 / 2) = 12 × 12 m.

3. Stocking densities (animals/ha)

Under Tir Gofal, overall stocking rates should not exceed 2.4 livestock units (LSU) /ha where:

- 1 dairy cow/suckler cow = 1 LSU
- 1 beef animal (over 24 months) = 1 LSU
- 1 beef animal (under 24 months old) = 0.6 LSU
- 1 breeding ewe (with or without lambs) = 0.15 LSU.

On agriculturally improved grassland the rate is 2.4 LSU/ha; for other mandatory habitats, e.g. semi-improved grassland, then the stocking density should not to exceed 1.0 LSU/ha overall. However, those rates can be modified on the basis that if the average rate is 1.0 LSU/ha for 12 months then it will be possible to graze 4.0 LSU/ha for 3 months (i.e. 4-times the average annual rate must not be exceeded), after which the area would then have to remain livestock-free for the remaining 9 months.

At present, 80% of Welsh Agricultural Land is designated Less Favoured Area. Where this is the case, livestock producers are entitled to receive financial support under the Tir Mynydd scheme (the Welsh form of the Hill Livestock (Compensatory Allowances) scheme).
http://new.wales.gov.uk/topics/environmentcountryside/farmingandcountryside/farming/agri_env_schemes/tirmynydd/?lang=en.
To comply with this, the proposals were a maximum of 1.8 LSU/ha in Disadvantaged Areas and 1.2 LSU/ha in Severely Disadvantaged Areas. The scheme will end in 2008 as described under the Rural Development Plan
(http://new.wales.gov.uk/topics/environmentcountryside/farmingandcountryside/ruraldevelopment/20072013ruraldevelopmentplan/?lang=en).

For those farmers in receipt of Single Payment Scheme support payments, however, there are cross-compliance requirements (Statutory Management Requirements (SMRs) and Good Agricultural and Environmental Condition requirements (GAEC)). If breeches of these compliance requirements are found on inspection, then payments may be reduced, withdrawn or even recovered. For example, GAEC9, which deals with avoidance of overgrazing and unsuitable supplementary feeding, does not specify a maximum grazing stocking density but requires that land and livestock be assessed on their condition.

4. Housing densities (animals/m^2)

Cattle

The Welsh Assembly Government recommendations for housing cattle in groups, states that '*the space allowance should be worked out in terms of the whole environment; the age, sex, liveweight and behavioural needs of the stock; the size of the group and whether any of the animals have horns, and should be based on expert advice'.*
In line with these recommendations, the scenarios in this report use the following space allowances per head of cattle:

- Dairy, Suckler and Beef over 24 months - 5 m^2/head
- Beef under 24 months - 3 m^2/head.

Sheep

As the focus of this report is on winter housing, space allowances for sheep are based on those deployed in the project's housing trials and the Welsh Assembly Government guidelines for pregnant ewes:

- Pregnant ewes - 1.33 m^2/head.

The Welsh Assembly Government recommended space allowances are listed below and can be found in the Code of Recommendations for the Welfare of Livestock, December 2005.

Lowland ewes (60 - 90 kg liveweight)	1.2 - 1.4 m^2 floor space / ewe during pregnancy.
Lowland ewes after lambing with lambs at foot up to 6 weeks of age	2.0 - 2.2 m^2 floor space / ewe and lambs
Hill ewes (45-65 kg liveweight)	1.0 - 1.2 m^2 floor space / ewe during pregnancy.
Hill ewes after lambing, with lambs at foot, up to 6 weeks of age,	1.8 - 2.0 m^2 floor space / ewe and lambs.
Lambs up to 12 weeks old	0.5 - 0.6 m^2 floor space / lamb
Lambs and sheep 12 weeks to 12 months old	0.75 - 0.9 m^2 floor space / lamb / sheep
Rams	1.5 - 2.0 m^2.

http://new.wales.gov.uk/docrepos/40382/epc/ahw/527660/G-450-05-06_English_LoRes.pdf?lang=en

Organic livestock housing densities

Organic livestock space requirements are more generous than conventional densities and ideally, the stock should have access to outdoor areas as well:

Stock	Weight	Soil Association indoor area requirement / head (m^2)	Minimum organic indoor area requirement / head (m^2)
Cattle	100 kg	2.6	1.5
	200 kg	4.4	2.5
	350 kg	7.0	4.0
Cattle	> 350 kg	8.7 with a minimum of 1.75 m^2 / 100 kg	5.0 with a minimum of 1 m^2 / 100 kg
Dairy cow		10.5	6
Bull		10 + 30 m^2 outdoor exercise area	10 + 30 m^2 outdoor exercise
Ewe		1.5	1.5
Ewe + lambs		2.0	2.0

http://www.ruralni.gov.uk/index/bussys/organic_production/organic_unit/livestock_housing1.htm
and http://www.defra.gov.uk/farm/Organic/standards/pdf/compendium.pdf

Calculating the amount of bedding required

Add up the total depth of bedding (m) that will be applied over the entire housing period and multiply that by the area (m^2) per animal: For instance, dairy cattle housed at 5 m^2 for 16 weeks with an initial 10 cm layer and 5 cm top-up layers each week thereafter; 5 (area, m^2) × 0.85 (depth, m) = 4.25 m^3/head. Then simply multiple this figure by the total number of cattle being housed, e.g. 72 × 4.25 = 306 m^3 is the total volume of bedding needed to house 72 dairy cattle over 16 weeks. Principally, the calculation is the same for sheep, except the total depth of bedding will be less over 8 weeks (10 cm + (7 × 5 cm)) = 0.45 m.

To convert volume to tonnes, divide the total volume by m^3/t depending on the woodchip's moisture content (see Table 5). For woodchip with 50% mc; 306 (m^3) / 3.224 (m^3/t) = 95 t.

Organic dairy cattle housed under the same conditions , except at 6 m^2/head; 6 × 0.85 = 5.1 m^3/head × 72 = 367.2 m^3 total volume of bedding, or 367.2 / 3.224 (50% mc) = 114 t.

Table 1: Shows the Tir Gofal maximum number of livestock on 40 and 200 ha holdings and the total weight of woodchip needed to house the cattle for 16 weeks and the sheep for 8 weeks.

Land type, livestock category and equivalent LSU	Housing density m²	Maximum head on 40 ha	Total t woodchip bedding (50% mc)	Maximum head on 200 ha	Total t woodchip bedding (50% mc)
Agriculturally Improved Grassland					
Maximum of 2.4 LSU/ha					
Dairy or Suckler cow = 1 LSU/ha	5	96	127	480	633
Beef (> 24 months) = 1 LSU/ha	5	96	127	480	633
Beef (< 24 months) = 0.6 LSU/ha	3	160	127	800	633
Pregnant Ewes = 0.15 LSU/ha	1.33	640	119	3200	594
Semi-Improved Grassland					
Maximum of 1.0 LSU/ha					
Dairy or Suckler cow = 1 LSU/ha	5	40	53	200	264
Beef (> 24 months) = 1 LSU/ha	5	40	53	200	264
Beef (< 24 months) = 0.6 LSU/ha	3	67	53	333	264
Pregnant Ewes = 0.15 LSU/ha	1.33	267	50	1333	248
LFAs (cover 80% of Wales)					
Disadvantaged Areas					
Maximum of 1.8 LSU/ha					
Dairy or Suckler cow = 1 LSU/ha	5	72	94.91	360	474.57
Beef (> 24 months) = 1 LSU/ha	5	72	94.91	360	474.57
Beef (< 24 months) = 0.6 LSU/ha	3	120	95	600	475
Pregnant Ewes = 0.15 LSU/ha	1.33	480	89.11	2400	445.53
Severely Disadvantaged Areas					
Maximum of 1.2 LSU/ha					
Dairy or Suckler cow = 1 LSU/ha	5	48	63	240	316
Beef (> 24 months) = 1 LSU/ha	5	48	63	240	316
Beef (< 24 months) = 0.6 LSU/ha	3	80	63	400	316
Pregnant Ewes = 0.15 LSU/ha	1.33	320	59	1600	297

Data used in the scenarios is highlighted.

The tables below provide a range of costs / head for woodchip bedding, illustrating the economic significance of different moisture contents and of sourcing low cost wood.

Table 2: Cost of woodchip £/head of Dairy or Suckler or Beef cattle > 24 months, when housed at a density of 5 m^2/head for 16 weeks with an initial 10 cm base layer and 15×5 cm top-up layers thereafter.

Woodchip Cost (£/t)	20 % mc	30 % mc	40 % mc	50 % mc	60 % mc
£2 /t	2.32	2.41	2.52	2.64	2.72
£10 /t	11.62	12.03	12.58	13.18	13.58
£20 /t	23.23	24.07	25.16	26.36	27.15
£30 /t	34.85	36.10	37.74	39.55	40.73
£40 /t	46.47	48.13	50.33	52.73	54.30
£50 /t	58.08	60.16	62.91	65.91	67.88
£60 /t	69.70	72.20	75.49	79.09	81.45

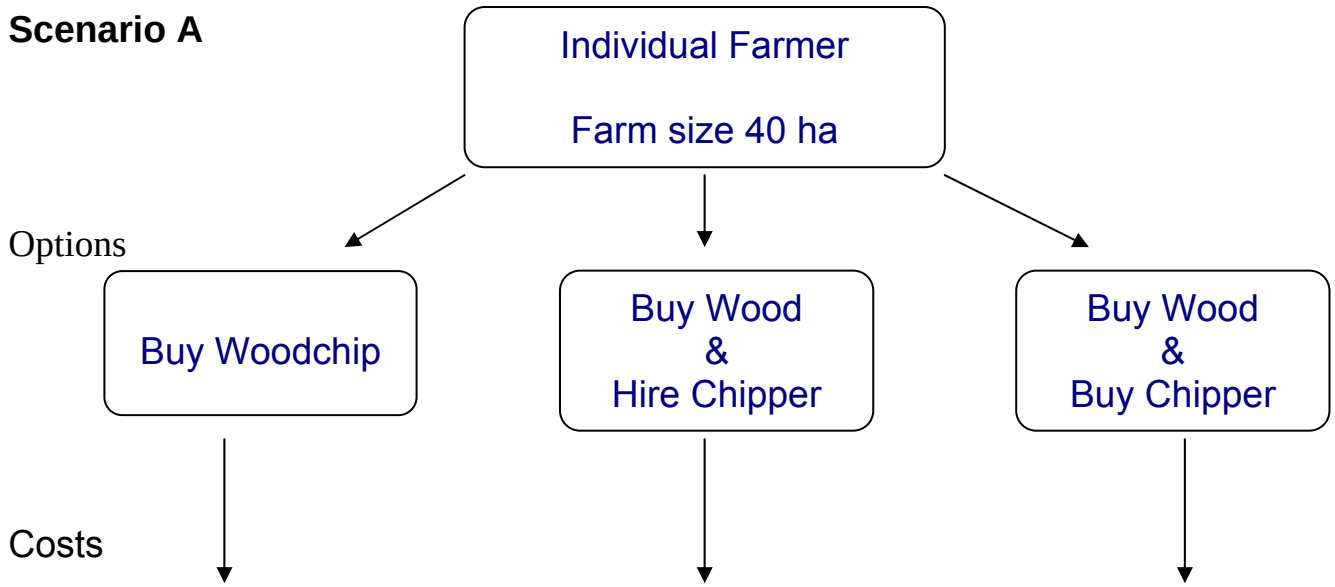
Table 3: Cost of woodchip £/head of Beef cattle < 24 months, when housed at a density of 3 m^2/head for 16 weeks with an initial 10 cm base layer and 15×5 cm top-up layers thereafter.

Woodchip Cost (£/t)	20 % mc	30 % mc	40 % mc	50 % mc	60 % mc
£2 /t	1.39	1.44	1.51	1.58	1.63
£10 /t	6.97	7.22	7.55	7.91	8.15
£20 /t	13.94	14.44	15.10	15.82	16.29
£30 /t	20.91	21.66	22.65	23.73	24.44
£40 /t	27.88	28.88	30.20	31.64	32.58
£50 /t	34.85	36.10	37.74	39.55	40.73
£60 /t	41.82	43.32	45.29	47.46	48.87

Table 4: Cost of woodchip £/head of Pregnant ewes, when housed at a density of 1.33 m^2/head for 8 weeks with an initial 10 cm base layer and 7×5 cm top-up layers thereafter.

Woodchip Cost (£/t)	20 % mc	30 % mc	40 % mc	50 % mc	60 % mc
£2 /t	0.33	0.34	0.35	0.37	0.38
£10 /t	1.64	1.69	1.77	1.86	1.91
£20 /t	3.27	3.39	3.54	3.71	3.82
£30 /t	4.91	5.08	5.32	5.57	5.74
£40 /t	6.54	6.78	7.09	7.43	7.65
£50 /t	8.18	8.47	8.86	9.28	9.56
£60 /t	9.82	10.17	10.63	11.14	11.47

Scenario A



Buy Woodchip	Buy Wood & Hire Chipper	Buy Wood & Buy Chipper
72 cattle (over 24 months) housed for 16 weeks	72 cattle (over 24 months) housed for 16 weeks	72 cattle (over 24 months) housed for 16 weeks
Weight of Wc: 94.91 t (50% mc)	Weight of Wc: 94.91 t (50% mc)	Weight of Wc: 94.91 t (50% mc)
Cost: £60/t	Wood: £2–15/t	Wood: £2–15/t
	Hire: £100/day ~ £1.05/t	Depreciation: £0.15/t
		Running costs: £0.35/t
Total £5,695	Total £290–£1,524	Total £237–£1,471
£41.87 /head	£4.03–£21.16 /head	£3.30–£20.43 /head
OR	OR	OR
480 breeding ewes housed for 8 weeks	480 breeding ewes housed for 8 weeks	480 breeding ewes housed for 8 weeks
Weight of Wc: 89.11 t (50% mc)	Weight of Wc: 89.11 t (50% mc)	Weight of Wc: 89.11 t (50% mc)
Cost: £60/t	Wood: £2–15/t	Wood: £2–15/t
	Hire: £100/day ~ £1.12/t	Depreciation: £0.15/t
		Running costs: £0.35/t
Total £5,341	Total £278–£1,437	Total £223–£1,381
£11.14 /head	£0.58–£2.99 /head	£0.46–£2.88 /head

Due to time pressures, the £/t paid for woodchip used in the housing trials was above average: IGER £70 /t (50% mc approx), ADAS £77 /t (34%, 53% and 55% mc) and Glynllifon College £110/t (25-40% mc).
It is uneconomic to buy pre-chipped wood under current market conditions for the following reasons.

- Woodchip prices include the cost of chipping, this report shows it is more cost effective to buy wood and hire or buy a chipper for quantities > 2t.
- Wood in the round has a smaller surface area than woodchip, so absorbs less moisture.
- Woodchip must be barn stored in low flat heaps with good ventilation to reach < 30% mc, whereas, timber and waste wood can be stored outside, taking up less space.
- Fresh cut 'green' wood has 45-60% mc, so if farmers buy green woodchip at £60/t they will pay up to £36/t for water, compared to £9/t for the water content of green round wood at £15/t.

Table 5: Highlights discrepancies in volume and weight between (softwood) woodchip moisture contents.

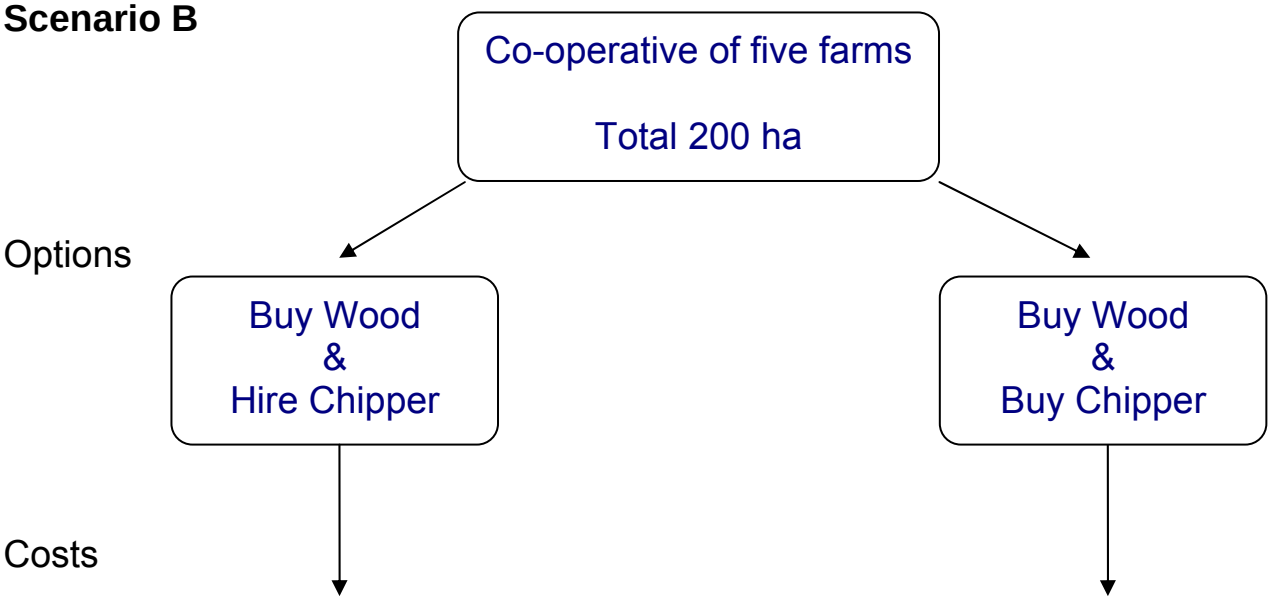
Woodchip % moisture	Volume (m^3/t)	Cost of water per tonne (£)	Dry weight of 10 t woodchip (t)	Cost of water per tonne (£)
0	3.69	0.00	10	0
10	3.67	0.03	9	6.00
20	3.66	0.11	8	12.00
30	3.53	0.77	7	18.00
40	3.38	2.03	6	24.00
50	3.22	3.79	5	30.00
60	3.13	5.46	4	36.00
		When buying by volume		When buying by weight

Between 0% and 22% moisture content, (28% when expressed on a dry weight basis, i.e. ((wet weight - oven dry weight) / oven dry weight) × 100), softwoods expand by approx 11.5% and hardwoods by approx 14% which counteracts the increasing mass of water from decreasing m^3/t. In addition, a cubic metre of woodchip is 60% air space, so only 40% of the volume is affected by the weight of water and the weight/volume ratio of wood and water is similar (wood 1 t : 1.47 m^3 and water 1 : 1 m^3).

Domestic fuels and livestock bedding require woodchips with < 30% mc. The woodchip supply chain in Wales is not currently geared to delivering calorific value, due to the time and space required to season the quantity of wood demanded, hence woodchip prices are variable and comparatively high to straw. However, the Forestry Commission has agreed with the Centre for Alternative Technology (CAT) to store large quantities of felled wood on site in order to dry it out. The FCW has also agreed that once implemented, this measure will service the needs of both the domestic woodfuels and agricultural markets.

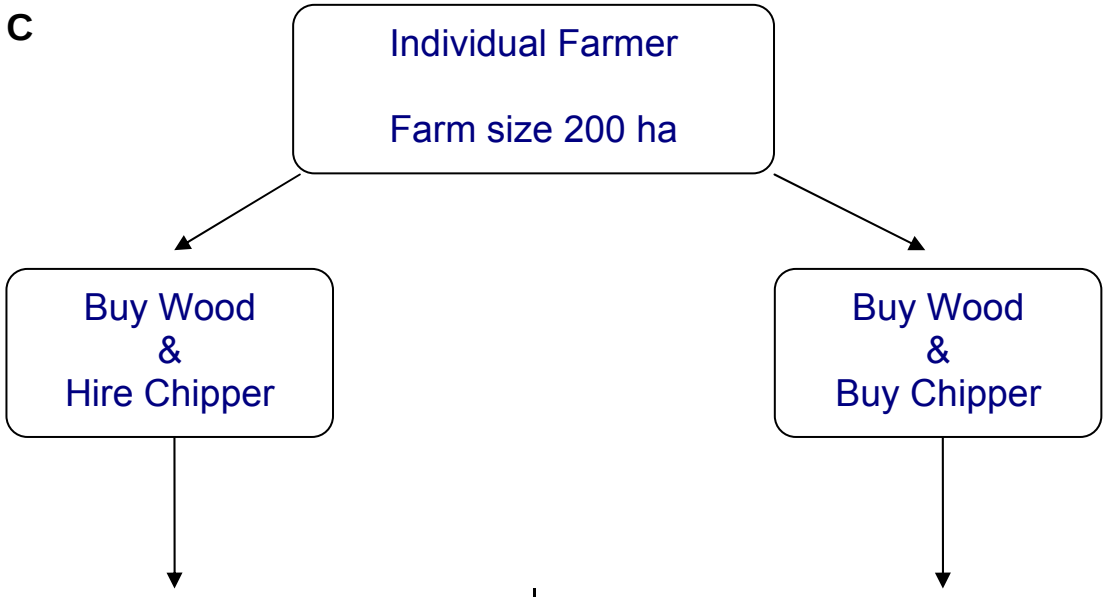
Scenario A has shown it is not cost effective to buy woodchip at £60/t, so the option is no longer included.

Scenario B



Buy Wood & Hire Chipper	Buy Wood & Buy Chipper
360 cattle (over 24 months) housed for 16 months	360 cattle (over 24 months) housed for 16 months
Total weight of woodchip: 474.57t (50% mc)	Total weight of woodchip: 474.57t (50% mc)
Wood: £2–15/t	Wood: £2–15/t
Hire: £250 for 5 days ~ £0.53/t	Depreciation: £0.15/t
	Running costs: £0.35/t
Total £240–£1,474 /farmer	Total £237–£1,471 /farmer
£0.67–£4.09 /head /farmer	£0.66–£4.09 /head /farmer
OR	OR
2,400 breeding ewes housed for 8 weeks	2,400 breeding ewes housed for 8 weeks
Total weight of woodchip: 445.53t (50% mc)	Total weight of woodchip: 445.53t (50% mc)
Wood: £2–15/t	Wood: £2–15/t
Hire: £250 for 5 days ~ £0.56/t	Depreciation: £0.15/t
	Running costs: £0.35/t
Total £228–£1,387 /farmer	Total £223–£1,381 /farmer
£0.10–£0.58 /head /farmer	£0.09–£0.58 /head /farmer

Scenario C



Options

Costs

Buy Wood & Hire Chipper	Buy Wood & Buy Chipper
360 cattle (over 24 months) housed for 16 months	360 cattle (over 24 months) housed for 16 months
Total weight of woodchip: 474.57t (50% mc)	Total weight of woodchip: 474.57t (50 % mc)
Wood: £2–15/t	Wood: £2–15/t
Hire: £250 for 5 days ~ £0.53/t	Depreciation: £0.15/t
	Running costs: £0.35/t
Total £1,199–£7,369	Total £1186–£7,356
£3.33–£20.47 /head	£3.30–£20.43 /head
OR	OR
2,400 breeding ewes housed for 8 weeks	2,400 breeding ewes housed for 8 weeks
Total weight of woodchip: 445.53 t (50 % mc)	Total weight of woodchip: 445.53 t (50 % mc)
Wood: £2–15/t	Wood: £2–15/t
Hire: £250 for 5 days ~ £0.56/t	Depreciation: £0.15/t
	Running costs: £0.35/t
Total £1,141–£6,933	Total £1,114–£6,906
£0.48–£2.89 /head	£0.46–£2.88 /head

Table 6: Summarises the costs involved when using home-grown wood or waste wood products at £2/t and compares the options of hiring or buying a chipper under each scenario. Attention is drawn to the right hand column '£/head over 3 years', which shows the average annual cost of housing cattle for 16 weeks each winter over the woodchip bedding's 3 year life span and the average annual cost of housing sheep for 8 weeks each winter over the woodchip bedding's 3 year life span. The option of buying woodchip at £60/t under scenario A has been omitted.

SCENARIO A

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
72 Cattle	94.91	0.15	0.35	2	237	3.30	1.10
480 Ewes	89.11	0.15	0.35	2	223	0.46	0.15

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
72 Cattle	94.91	1	100	2	290	4.03	1.34
480 Ewes	89.11	1	100	2	278	0.58	0.19

SCENARIO B: Buying in bulk as a Co-op reduces costs /farmer and is therefore the cheapest of the 3 scenarios

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	0.15	0.35	2	237	0.66	0.22
2400 Ewes	445.53	0.15	0.35	2	223	0.09	0.03

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	5	250	2	240	0.67	0.22
2400 Ewes	445.53	5	250	2	228	0.10	0.03

SCENARIO C

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	0.15	0.35	2	1186	3.30	1.10
2400 Ewes	445.53	0.15	0.35	2	1114	0.46	0.15

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	5	250	2	1199	3.33	1.11
2400 Ewes	445.53	5	250	2	1141	0.48	0.16

Table 7: Summarises the costs involved when short round wood is purchased at £15/t and compares the options of hiring or buying a chipper under each scenario, and as above, concludes in the right hand column with the average annual cost of housing cattle for 16 weeks each winter over the woodchip bedding's 3 year life span and the average annual cost of housing sheep for 8 weeks each winter over the woodchip bedding's 3 year life span.

SCENARIO A

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
72 Cattle	94.91	0.15	0.35	15	1471	20.43	6.81
480 Ewes	89.11	0.15	0.35	15	1381	2.88	0.96

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
72 Cattle	94.91	1	100	15	1524	21.16	7.05
480 Ewes	89.11	1	100	15	1437	2.99	1.00

SCENARIO B: Buying in bulk as a Co-op reduces costs /farmer and is therefore the cheapest of the 3 scenario

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	0.15	0.35	15	1471	4.09	1.36
2400 Ewes	445.53	0.15	0.35	15	1381	0.58	0.19

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	5	250	15	1474	4.09	1.36
2400 Ewes	445.53	5	250	15	1387	0.58	0.19

SCENARIO C

BUY Chipper

Livestock #	Bedding t	Depreciation/t	Running costs/t	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	0.15	0.35	15	7356	20.43	6.81
2400 Ewes	445.53	0.15	0.35	15	6906	2.88	0.96

HIRE Chipper

Livestock #	Bedding t	Days	Hire cost £	Wood £/t	Total £	£/head	£/head over 3 yrs
360 Cattle	474.57	5	250	15	7369	20.47	6.82
2400 Ewes	445.53	5	250	15	6933	2.89	0.96

5. Woodchip bedding's 3 year cycle

On the evidence from the pot trials (report 7), it is considered that the volumetric reduction of bulk matter within the first season's composting had little or no effect on the volume of bedding available for the second winter's housing, as any reduction from decomposition is counterbalanced by the remnant manure and waste feed fraction within the composted bedding. However, time pressure did not allow assessment of the percentage of volumetric reduction between the second and third winter's housing period. So, to avoid there being insufficient bedding in the final winter, an additional 15% has been accounted for within the 3 year cycle. It is recommended however, that where additional bedding is needed in the third and final winter's housing period, farmers should if possible, use straw. This will boost microbial decomposition and add to the quality of the WM compost in the final stages of its life cycle. The costs of using an extra 15% straw or woodchip to top-up the bedding in the final winter housing period are shown in the table below.

Table 8: The average annual cost (£/head) of using woodchip bedding over 3 winter housing periods (16 weeks for cattle and 8 weeks for sheep) with a 15% bedding supplement included, either as woodchip or as straw; wood is assumed to cost £2/t with associated costs included, and the additional straw to cost £50/t.

SCENARIO A	Wood £2/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
72 Cattle	1.26	2.32
480 Ewes	0.18	0.23
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
72 Cattle	1.54	2.56
480 Ewes	0.22	0.27
SCENARIO B:	Wood £2/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	0.25	0.46
2400 Ewes	0.04	0.05
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	0.26	0.47
2400 Ewes	0.04	0.05
SCENARIO C	Wood £2/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	1.26	2.32
2400 Ewes	0.18	0.23
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	1.28	2.33
2400 Ewes	0.18	0.23

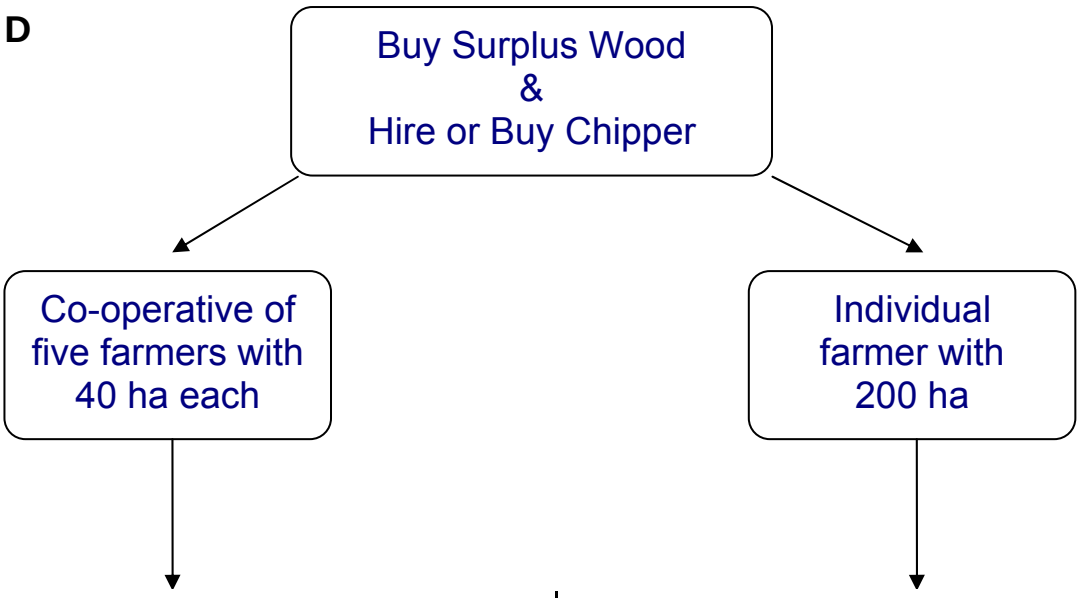
Table 9: The average annual cost (£/head) of using woodchip bedding over 3 winter housing periods (16 weeks for cattle and 8 weeks for sheep) with a 15% bedding supplement included, costs / option are the same as Table 8 except the price of wood is £15/t.

SCENARIO A	Wood £15/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
72 Cattle	7.83	8.03
480 Ewes	1.10	1.03
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
72 Cattle	8.11	8.27
480 Ewes	1.15	1.07

SCENARIO B:	Wood £15/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	1.57	1.61
2400 Ewes	0.22	0.21
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	1.57	1.61
2400 Ewes	0.22	0.21

SCENARIO C	Wood £15/t	Straw £50/t
BUY Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	7.83	8.03
2400 Ewes	1.10	1.03
HIRE Chipper Livestock #	£/head/winter over 3 years with an additional 15% woodchip in Year 3	£/head/winter over 3 years with an additional 15% straw in Year 3
360 Cattle	7.85	8.04
2400 Ewes	1.11	1.04

Scenario D



Costs

480 breeding ewes EACH	2,400 breeding ewes
1000t (50 % mc) of wood purchased	1000t (50 % mc) of wood purchased
Buy Chipper	Buy Chipper
Wood: £2–15/t Depreciation: £0.15/t Running costs: £0.35/t	Wood: £2–15/t Depreciation: £0.15/t Running costs: £0.35/t
Total cost £500-£3,100 /farmer	Total cost £2,500-£15,500
Hire Chipper	Hire Chipper
Wood: £2–15/t Hire: £500 for 10 days = £0.50/t	Wood: £2–15/t Hire: £500 for 10 days = £0.50/t
Total cost £500-£3,100 /farmer	Total cost £2,500-£15,500
A total of 446t is used as bedding	446t is used as bedding
If the remaining 555t is sold at £30/t	If the remaining 555t is sold at £30/t
Turnover = £16,650	Turnover = £16,650
Profit £230-£2,830 /farmer depending on the purchase price of the wood	Profit £1,150-£14,150 depending on the purchase price of the wood

Individual farmers with 2,400 ewes should be aware that the woodchip used for bedding will require a space of 30 × 24 × 2 m^3 before being put in the pens and the remaining 555t for sale will take up 30 × 30 × 2 m^3 with ample ventilated space above the woodchip pile to prevent condensation forming on the roof above.

6. Straw

Table 10: Wholesale price of straw on 14th March 2008 by region across the UK mainland

	Pick-up baled barley straw	Pick-up baled wheat straw	Big sq. baled barley straw	Big sq. baled wheat straw
North East	50	-	40	29
East Yorks	50	-	40	28
N Midlands	55	40	38	27
E Midlands	44	38	38	33
C Midlands	40	35	40	35
E Counties	45	40	38	35
South-East	50	30	35	30
South	52	-	52	42
South-West	65	60	55	50
South Wales	50	40	45	40
SE Scotland	42	-	30	20

Prices supplied by the British Hay & Straw Merchants Association

Straw merchants use the above prices, supplied by the British Hay and Straw Merchants Association (BHSMA) and published in the Farmer's Weekly to determine where to buy the cheapest straw. Prices differ between wheat and barley as well as bale size. Therefore, Wales's straw imports may come from anywhere in England, not just Shropshire or Norfolk and a single delivery may consist of straw from a number of locations, depending on regional prices at different times. Quotes (£/t) for deliveries to 3 points in Wales; Bangor, Aberystwyth and Carmarthen, representing north, mid and south Wales, were obtained from 3 merchants in Shropshire; Church Stretton, Oswestry and Ludlow on the 26th April 2008; the Ludlow and Oswestry merchants reported static prices since September 2007, whereas the Church Stretton merchant's prices had dropped by £4/t.

Table 11: Lists the quotes (£/t) given by 3 Shropshire straw merchants for wheat straw in Hesston bales.

From / To	Bangor	Aberystwyth	Carmarthen
Church Stretton	£60	£60	£64
Oswestry	£65	£70	£70
Ludlow	£65	£58	£70
Mean	**£63.33**	**£62.66**	**£68**

It is the wholesale price of straw, not its place of origin that determines its final price. The straw quoted from Ludlow to Bangor, had recently been bought in Yorkshire, whereas the straw quoted for the shorter journey from Oswestry to Bangor, had also only come from Cambridgeshire, but had been purchased at a slightly higher price, hence they arrive in North Wales at the same price. Therefore, it is economic for farmer to use local merchants, unless they're going to purchase straw directly from the producer and collect it themselves.

Housing trials

The following two tables contrast the bedding costs from the housing trials; particular attention is drawn to the weight and cost of woodchip used /animal in the two right hand columns.

Table 12: Total and per animal costs for woodchip used at IGER, ADAS Pwllpeiran and Glynllifon

Site	Woodchip used t	Total cost £	Cost /t £	Housing density m²/head	Weight of woodchip used /animal (kg)	Cost of woodchip /animal (£)
Sheep						
ADAS, Pwllpeiran	13.4	1035.17	76.99	0.95	149	11.50
IGER	3.98	273.63	68.70	2.42	125	8.55
Glynllifon	20.9	2290.95	109.52	1.43	111	12.19
Cattle						
ADAS, Pwllpeiran	15.6	1215.20	77.70	5.64	652	50.63
IGER	14.7	1029.37	70.19	6.45	1222	85.78
Glynllifon	27.7	3036.84	109.72	3.55	692	75.92

The average cost of woodchip used under sheep (128 kg/head at £85/t) = £10.75/head

The average cost of woodchip used under cattle (855 kg/head at £86/t) = £70.78/head

Table 13: Total and per animal costs for straw used at IGER, ADAS Pwllpeiran and Glynllifon

Site	Straw used t	Total cost £	Cost /t £	Housing density m²/head	Weight of straw used /animal (kg)	Cost of straw /animal (£)
Sheep						
ADAS, Pwllpeiran	0.66	34.65	52.50	0.95	22.0	1.16
IGER	0.50	27.50	55.00	2.42	15.6	0.86
Glynllifon	0.13	5.46	42.00	1.50	8.13	0.34
Cattle						
ADAS, Pwllpeiran	1.51	79.28	52.50	5.64	189	9.91
IGER	3.44	189.20	55.00	6.45	287	15.77
Glynllifon	0.77	32.63	42.00	6.77	257	10.88

The average cost of straw used under sheep (15 kg/head at £50/t) = £0.79/head

The average cost of straw used under cattle (244 kg/head at £50/t) = £12.18/head

The different housing systems deployed at each site and the variation in woodchip prices are reflected in the quantities of bedding used and the cost per animal. In all three trials, straw was cheaper than woodchip.

7. Chippers

Laimet HP 25 New: £ 22,925 excl VAT. £ 7,629 ex-trade 6 years old

The Laimet HP-25 chipper uses a conical screw blade which also functions as a feed unit. There are five different chip sizes, ranging from 15–25 mm up to 60–100 mm although it can chip wood up to 230 mm in diameter. The quoted output ranges from 40 to 120 m^3 per hour (12.5–37 t/hr), depending on the blade used as well as the size and type of wood. However, a Laimet HP-25 owner suggested that a maximum output of 12.5 t/hr (depending on manpower) is a more realistic rate. This chipper is suitable for all types of clean wood: coniferous and deciduous, thinnings, tree tops, pruned and unpruned saplings, blocks, sawn surfaces and even frozen wood, but it should be noted that timber/wood should always be chipped green, because the Laimet's single blade will blunt quickly on dry wood, particularly spruce. The blade should be sharpened every full working day (8–10 hrs), this can be done by the owner and takes approximately 20 minutes. Once the blade has worn down, it is more cost effective to have it re-tipped with hard welding than to buy a replacement; a new blade costs £4,805. The HP 25 design enables the owner to carry out all general service and maintenance requirements themselves, so avoiding call-out costs.

Costs

Blade sharpening every 8–10 hrs	= £n.a.
Blade re-tipping £1000 /600 hrs	= £1.66/hr
Anvil repair £100 /500 hrs	= £0.20/hr

Running costs (not incl. diesel or labour) = £1.86/hr excl VAT.

Data courtesy of Fuelwood Harvesting

Heizohack HM8-400 New: £ 25,695 excl VAT. £ 8,551 ex-trade 6 years old

The output of the Heizohack HM8-400 and the 8-400K (crane fed) are the same, as the infeed and drum size are identical on both machines. The factory output figure for this model is 40 $m^{3/}$hr, (12.5 green t/hr) with conveniently stacked cord wood (1 cord = 128 ft^3 (4' × 4' × 8'), equivalent to 3.6 m^3, consisting of 66% solid wood, 12% air space and 22% of bark) or can be as much as 55 $m^{3/}$hr when being loaded from a lorry or forwarder. The benefit of the hand-fed model over the crane-fed is apparent when feeding smaller diameter timber as the drum can be kept full.
The annual running costs for the chipper are obviously dependant on the type and volume of timber being chipped and any contaminants in the timber. The main wearing parts (as with any chipper) are the blades and the anvil. The design of the Heizohack blades are such that they allow 10 mm of sharpening, this equates to 5 sharpenings when cutting good clean timber with no contaminants. The HM8-400 blades need sharpening every 30–40 chipping hours (unless damaged due to stones, nails etc). For efficiency, three sets of blades are used in rotation, one in use, one spare set with the chipper and one away being sharpened.

Costs

Set of eight blades (@ £10.00 each) = £240.00 excl. VAT

Average sharpening costs per set of blades = £24.00 excl. VAT

Rotating three sets of blades as above will give around 630 hours of chipping.

Anvil/shearbar = £230.00 excl. VAT

The anvil/shearbar is four-sided and in normal use will last approx 400 hours per side.

Blade costs = £240

Sharpening = £360 } = £600 /630 hours = £0.95 /hr

Anvil costs = £230 divided by 1600 hours = £0.14/hr.

Total blade and anvil costs = £1.09/hr.

500 hr service costs (approximate) = £165 excl. labour & VAT.

Running costs (not incl. diesel or labour) = £1.42/hr excl. VAT.

Data courtesy of A C Price

Greenmech CM 220 MT 55 New: £ 18,950 excl VAT. £ 6,306 ex-trade 6 years old

The Greenmech 220 uses 6 disc blades mounted on a flywheel and have a fully sharpened circumference, so only a third of the cutting edge on each disc is in use at any one time, the rest of the cutting circumference is kept in reserve. The blades can be rotated to the next sharp section when performance is lost, giving less down time and a longer period between sharpenings than conventional flat blades or flail systems. The Greenmech 220 MT 55 is produced as both a PTO and a stand alone unit with an output of 7 t/hr.
The blades need rotating every 50 chipping hours (unless damaged due to stones, nails etc), and then removing and sharpening every 150 hrs. Blades can be sharpened 6–10 times (1050–1650 hrs) before needing to be replaced. Replacement sets cost £ 177, or £ 29.50 /blade.
The Greenmech 220 has two anvils which have a 4–5 yr life-span (2000–4000 hrs under trade-use conditions). Each anvil costs £ 120 to replace or £ 240 for both. This should be taken into consideration if farmers are buying a second hand ex-trade chipper.

Costs

Sharpening set of six blades @ £50 /150 hrs	= £0.33/hr
Blade replacement @ £177 set of 6 /1000 hrs	= £0.18/hr
Anvil replacement @ £240 set of 2 /3000 hrs	= £0.08/hr
Servicing @ approx £165 excl. labour & VAT	= £0.33/hr
Running costs (not incl. diesel or labour)	**= £0.92/hr excl. VAT.**

Data courtesy of Greenmech Ltd

Jenson A328 New: £ 16,500 excl VAT. £ 5,491 ex-trade 6 years old

The Jenson A328 model has been discontinued and replaced by the A340. It has two disc blades similar to the Greenmech 220 . The anvil needs turning every 40 hrs and daily maintenance consists of torquing the blade bolts, greasing the feed roller shafts and checking the belt tension. Output is 5 t /hr.

Costs

Blade sharpening @ £50 /40 hrs	= £1.25/hr
Blade replacement @ £300 /280 hrs	= £1.07/hr
Anvil repair @ £25 /80 hrs	= £0.31/hr
Anvil replacement @ £300 /280 hrs	= £1.07/hr
Servicing @ £100 /500 hrs	= £0.20/hr
Running costs (not incl. servicing, diesel or labour)	**= £3.70/hr excl. VAT.**

Data courtesy of Elite Plant Hire and Arborcut

Depreciation

Depreciation is calculated using the reducing balance method. Buying an ex-trade chipper costs less initially, but may have higher maintenance costs than a new chipper (Table 14). An ex-privately owned chipper is initially more expensive, because it depreciates at 12.5 % (Tables 15 and 16).

Table 14: Shows depreciation rates for new chippers and 'trade' chipper (based on 500 – 800 working hours /yr, whereas private use is < 500 hours /yr).

Chipper model	New £	Trade: Year 1 25% (£)	Trade: Year 2 15% (£)	Private: Year 1 12.5% (£)
Laimet HP 25	22,925	5,731	2,579	2,866
Heizohack HM8-400	25,695	6,424	2,891	3,212
Green mech 220 MT 55	18,950	4,738	2,132	2,369
Jenson A328	16,500	4,125	1,856	2,063

Table 15: Depreciation rates for ex-trade chippers; depreciation for the first year after purchase is calculated at 12.5 % for a unit used < 500 hours /yr or 15 % for a unit used for 500 – 800 hours /yr.

Ex-trade Model	Price of a 6 yr old ex-trade chipper	Depreciation in yr 6 (£)	Output t /hr	£ /t depreciation (12.5 %) with < 500 hrs use /yr	£ /t depreciation (15 %) with < 800 hrs use /yr
Laimet	7,629	954	12.5	0.15	0.11
Heizohack	8,551	1,069	12.5	0.17	0.13
Green mech	6,306	788	7	0.13	0.09
Jenson	5,491	686	5	0.11	0.08

Table 16: Depreciation rates for ex-privately owned chippers; depreciation is calculated at 12.5 % for a unit used < 500 hours /yr or 15 % for a unit used for 500 – 800 hours /yr.

Ex-private Model	Price of a 6 yr old ex-private chipper	Depreciation in yr 6 (£)	Output t /hr	£ /t depreciation (12.5 %) with < 500 hrs use /yr	£ /t depreciation (15 %) with < 800 hrs use /yr
Laimet	10,289	1,286	12.5	0.21	0.15
Heizohack	11,532	1,441	12.5	0.23	0.17
Green mech	8,505	1,063	7	0.17	0.13
Jenson	7,405	926	5	0.15	0.11

Running costs

Table 17: Components of running costs (£ /t).

Part	Action	Laimet	Heizohack	Green mech	Jenson
Blades	Sharpened	nil - DIY	0.05 /t	0.05 /t	£ 0.25 /t
	Re-tipped	£ 0.33 /t or	dna	dna	dna
	Replaced	£ 1.60 /t	0.08 /t	0.03 /t	£ 0.21 /t
Anvil	Turn	dna	every 400 hrs x4	dna	every 40 hrs
	Repair	£ 0.02 /t	dna	dna	£ 0.05 /t
	Replace	dna	0.01 /t	0.01 /t	£ 0.21 /t
	Service	dna	0.03 /t	0.05 /t	0.04 /t
Output	t / hr	12.5	12.5	7	5
Running costs:	£ /t	0.35	0.17	0.14	0.76

8. Conclusions

This section of the report has shown that woodchip is an economically viable alternative to straw at current market prices, when round wood is purchased and initial costs are spread over the bedding's 3 year life span.

Table 18: Compares the mean cost /head /year (over 3 years) to house 72 cattle for 16 weeks or 480 ewes for 8 weeks on woodchip at the housing densities and bedding rates set out in section 2 of this report. Assuming a chipper was hired for 1 day, the wood was bought for £15/t and 15% extra bedding was required to top-up the woodchip pens in the final year. Straw bedding data is based on mean weights and costs from the housing trials at IGER Plas Gogerddan, ADAS Pwllpeiran and Glynllifon College in 2006.

40 ha	Total cost of woodchip bedding /head /year	Total cost of straw bedding /head /yr
72 Cattle (16 weeks)	£8.04	£23.31
480 Ewes (8 weeks)	£1.14	£0.75

The economic benefit of re-using the woodchip bedding is clearly demonstrated by the cattle data above. The cost differences are due to the large quantities of expensive straw that cattle require over a 16 week housing period, each and every winter, whereas the costs of woodchip bedding are spread over 3 winters.

The report has established it is uneconomic to buy pre-chipped wood in the current market, so if farmers choose to use woodchip as an alternative bedding material to straw, it's recommended that they buy timber or waste wood and hire or buy a chipper.

Further cost savings are made if a group of farmers form a co-operative and spread the costs of chipper hire or depreciation and running costs of a group owned unit. In addition, if farmers have the covered space to store extra woodchip, then bedding costs can be offset against sales revenue or even developed into a profit generating enterprise.

A simple but effective system, widely used in Scandinavian countries for drying large quantities of woodchip, is to lay a perforated pipe or lattice of pipes underneath the woodchips, attached to a compressor that blows air through. This not only reduces the length of time required to dry the woodchip, but also achieves lower moisture content than just leaving them to air-dry naturally. It has not been possible to find out the cost involved, but for large quantities of stored woodchip, it would certainly seem very beneficial.

Mae'r Prosiect Sglodion Pren ar gyfer Sarnau Da Byw a gyflenwir gan Hybu Cig Cymru yn derbyn arian cyfatebol gan y Comisiwn Coedwigaeth, Asiantaeth yr Amgylchedd Cymru a Llywodraeth Cynulliad Cymru fel rhan o Cyswllt Ffermio.

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