Ramial Woodchip production and use

WOOFS Technical Guide 1

ORGANIC RESEARCH CENTRE

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The European Agricultural Fund for Rural Development: Europe investing in rural areas

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Can Ramial Chipped Wood (RCW) produced on farm from the management of trees and hedges be used as a sustainable source of fertility and organic matter for arable and horticultural production? The WOOdchip for Fertile Soils (WOOFS) EIP Operational Group have investigated this innovative technique, linking tree and hedge management with annual cropping, through on-farm trials run over a three-year period. This is the first of three short technical guides outlining observations and results from these trials. This guide focuses on the logistics and economics of using RCW.

The maintenance of soil organic matter (SOM) in agricultural soils is important for soil fertility, soil structure and long-term soil health. Sustaining and enhancing SOM is a common challenge on regularly cultivated soils and farmers often employ a combination of different methods. On stock-free farms, in addition to the use of legume leys and green manures, repeated applications of compost can give long term improvements in SOM. But this material either needs to be sourced externally which can be costly and unsustainable or produced and composted on farm which requires space and time for the composting process to take place. One possible alternative to compost is to use woodchip produced on farm from the management of trees and hedges as a soil improver, either composted, or alternatively, applied fresh as Ramial Chipped Wood (RCW).

What is Ramial Chipped Wood (RCW)?

RCW is fresh un-composted woodchip made from smaller diameter younger tree branches. Nutritionally these are the richest parts of trees, with young tree branches containing as much as 75% of the minerals, amino acids, proteins, phytohormones and enzymes found in the tree[1]. A review of the use of RCW in agricultural systems documents evidence for increased soil biological activity and soil organic matter (SOM) associated with its application to cultivated soils[2]. Chipping or crushing the smaller diameter green branch wood in winter when the leaves have fallen encourages fast entry of soil microorganisms, enabling both nutrients and energy to be transferred more quickly to the soil humus complex[3]. Ideally material should be less than 7 cm in diameter and spread in autumn/winter soon after chipping to keep the chip moist and provide optimum conditions for decomposition.

RCW on soil at Down Farm

Hazel Short Rotation Coppice at Wakelyns Agroforestry

RCW: helping farmers realise the benefits of trees and hedges on farm

Hedges and trees can deliver a wide range of ecosystem services in the agricultural landscape and can help to mitigate some of the negative impacts of intensive agriculture. However, in the UK beyond the support available via agri-environment schemes there are currently few incentives for farmers to value these trees and hedges, especially in arable areas where ease of access for large machinery is often prioritised. The requirement for smaller diameter material make hedges and short rotation coppice (SRC) agroforestry systems ideal for RCW production. RCW offers the potential for a sustainable source of fertility and organic matter that farmers can grow themselves whilst also providing an economic incentive for both the management of existing, as well as the establishment of new, on-farm woody resources. RCW production can be combined with extraction of the larger material for firewood or other uses.

The WOOFS Trials

The three trial farms are all livestock free with no animal inputs, and fertility comes from fertility building crops, compost and/or mineral nitrogen.

Table 1: Farms participating in the trials and treatments used in the trials

Farm	Type	Treatments (3 replicates)	Application rate and timing	
Tolhurst Organics	Organic vegetable production	1. RCW from mixed hedgerow 2. Composted woodchip 3. Control of nothing	40 - 70 m^3/ha applied to 1st year of 2-year legume ley	
Wakelyns Agroforestry	Agroforestry alley cropping with organic arable rotation	RCW from: 1. Poplar SRC agroforestry 2. Willow SRC agroforestry 3. Hazel SRC agroforestry 4. Mixed hedgerow 5. Control of nothing	40 m^3/ha applied to 1st year of 2-year legume ley 80 m^3/ ha applied to 2nd year of half the plots	
Down Farm	Conventional arable cropping	1. RCW from mixed hedgerow 2. Green waste compost 3. Control of nothing	100 - 150 m^3/ha applied to winter stubble before sowing of spring crop (barley/oil seed rape)	

Production of RCW on farm – how many trees do you need?

The on-farm production and use of RCW – as close as possible to the source – makes sense, due to the bulky nature of woodchip, to minimise transport costs. RCW can either be made by chipping material produced from the management of existing trees and hedges and/or by planting areas with trees for future woodchip production. To estimate the current potential availability of woodchip on farm it is best to start with an inventory of the existing trees and hedges and those that are suitable for managing for RCW production. Coppicing, pruning and thinning can all produce the smaller diameter branch wood and brash needed for RCW production. Table 2 gives average yield figures from WOOFS and earlier trials for guidance. However, it should be noted that yields will vary according to; site specific growing conditions (e.g. soil type, geographic location); tree species; coppice rotation length and planting density. Tree growth rates are generally highest in the first 10-20 years following coppicing, for example hazel SRC has a higher rate of annual biomass gain when coppiced between three and six years compared to older stools[4]. When planning to plant for RCW production it is a good idea to consider coppice rotation lengths in relation to your crop rotation to ensure that access to the trees for harvest is possible, for example if you have a 5 year rotation with 1 year ley, planning to coppice the trees on a 5-year rotation to coincide with the ley phase of the rotation could make sense.

Spreading RCW using modified muck spreader at Wakelyns Agroforestry

Table 2: Average volumes of woodchip from different systems and the quantity needed to provide 60m^3 of RCW to treat 1ha of land annually.

System	Coppice rotation	Average (range) volume of RCW (m^3)	Total for 60m^3 RCW	Total length/ trees in coppice rotation for 60m^3 RCW annually
100m mixed species hedge (100-200 trees)	10 years	12.75 (8 - 17.5)	470 m	4.7 km
100m hazel SRC agroforestry row (133 trees)	5 years	11 (8 – 14)	546 m	2.7 km
100m willow SRC agroforestry row (165 trees)	2 years	5 (4 – 6)	1200 m	2.4 km
Brash per tree cut for fuel logs (willow)*	7 years	1.14	52 trees	370 trees

** plus around 0.5m^3 of logs per tree*

Assumptions:

- Volumes based on actual figures from RCW trial sites and established systems[5,6]
- Hedges are allowed to grow upwards and coppiced at approximately 7 m height
- Brash chipping assumes that all material with a diameter greater than 7 cm is taken for logs

RCW production on farm

The first coppice cut on older hedges will usually give higher volumes of material than once a rotation is established. For example, 35 m^3 of woodchip per 100 m was produced from the mature unmanaged field boundary hedge that was coppiced at Down Farm. This compares favourably with production figures of 21-29 m^3 per 100 m from the first cut found on other farms[5], however the woodchip from older hedges may also include larger diameter material less suited for RCW and the woodchip may be better suited for other uses (e.g. woodfuel[4,8]).

The arable trial field at Down Farm was 14.6 ha so to treat the whole field at 60 m^3/ha, 2.5 km of first cut hedgerow would need to be coppiced or 6.8 km of hedge in a 10-year rotation (Table 2). Wakelyns Agroforestry using short rotation coppice (SRC) agroforestry offers one possible solution; SRC hazel and willow for woodchip production are grown in the field in an agroforestry system with arable and vegetable cropping in the alleys between the rows, and the SRC provides enough woodchip to heat the farmhouse with plenty left over for soil fertility[7].

In order to use RCW at scale on larger arable fields, a combination of harvesting existing trees and hedges and planting fast-growing coppice species such willow, poplar and hazel either in rows in the field (alley cropping) or in an unproductive corner is likely to be the most efficient and cost-effective method of producing RCW.

Based on the willow coppice production figures from his farm presented in Table 2 Iain Tolhurst has estimated that in order to apply RCW to 2 ha every seven years he would need around 20% tree cover on his farm.

Paul Ward, at Wakelyns Agroforestry also recommends willow: "If you want lots of woodchip quickly plant willow in single rows it is easier to chip and handle. Hazel is better quality for fuel. Poplar is poor as it absorbs moisture from the moment it's cut, has brittle sticks, is hard to chip and doesn't grow in straight lines, suckers make cutting time consuming."

What's the easiest method of producing RCW? If you only want RCW Iain Tolhurst suggests that you: "grow and harvest it as a crop, plant in rows or to square off a field and coppice on a slightly shorter rotation – if you use different species choose species with similar growth rates (e.g. willow and poplar) and keep them separate."

Willow coppice at Tolhurst Organics

Application and application rates

RCW was applied in winter to the first year of a fertility-building ley at two of the farms and prior to a spring crop at the other (Table 1). It is recommended to apply RCW green in winter to the soil surface[1,2]. As a precaution against potential nitrogen lock-up in the first year, the RCW in these trials was either applied to a legume ley or accompanied by an application of mineral nitrogen, the trial farms were all commercial farms and application of RCW without these measures was not tested.

RCW application rates reported in previous studies vary from 10 tonnes/acre (roughly equivalent to 60 m^3/ha)[10] to 150-200 m^3 per ha in the first year for the regeneration of degraded soils with much lower follow up application rates of 10-20 m^3 by the fourth year[2]. The application rates used in the trials ranged from 40 m^3 to 150 m^3 per hectare depending on the available material and rates between farms were not directly comparable. At Wakelyns a comparison was made between plots with a single application of 40 m^3 onto the legume ley and plots with an additional follow up application of 80 m^3, results suggest some small increases of the effects of the amendment with a higher application rate applied in a successive year (See WOOFS Technical Guide 2 for detail).

Ground conditions may play a part in decision making, RCW production and application is best carried out in winter, however this is when the ground conditions may not be suitable for travelling on with machinery. At Wakelyns Agroforestry the farmer found that in order to chip the material fresh it had to be moved to the chipper or the chipper moved to it, which was not ideal in winter as it meant traveling on wet soil and associated compaction.

Harvest, chipping and applying the woodchip

The WOOFS RCW trials used a range of different machinery sizes and scales. At Down Farm larger scale machinery was used, the hedges were coppiced with tree shears, material was then processed with a fuel-grade, crane-fed chipper and a contract Vredo muck spreader was used to spread the chip (See photos on page 3 and 6). At the other end of the scale the hedge and trees at Tolhurst Organics were coppiced by hand using chainsaws, material chipped with a small Timberwolf hand-fed chipper and spread using a rear discharge muck spreader. The manure spreader used at Wakelyns was modified with a shield added to allow more accurate application (See photo on page 3). A rear discharge, moving floor manure spreader is ideal for applying both compost and woodchip. Spreading costs are generally £0.5-1.6 per cubic metre depending on whether farm machinery is used or contractors employed.

The different scales have their advantages and disadvantages, choice of best method will depend on the number, size and location of the trees to be coppiced and available machinery. With shorter hedge lengths and a smaller numbers of trees smaller-scale manual methods are likely to be more appropriate, longer hedge lengths and more trees will be better suited to larger-scale methods. Previous trials[6,8] on hedge coppicing have looked in detail at the costs of different scales and found that in general at least 250 m of hedge is needed to justify the costs of hiring in larger-scale machinery with the associated haulage costs.[6,8]

Chipping at Down Farm

TOP for efficiency

The most efficient application method in terms of time was Tolhurst Organics where the trial set up enabled material to be coppiced and chipped straight into a muck spreader and then applied to the field in one operation. Cut coppice stems and woodchip are bulky materials and the more handling or moving required the more costly and time-consuming the operation becomes. For example, the cost to move the woodchip at Down Farm was estimated to be £1.25 /m³ and took most of a day to complete. However, the biggest unforeseen cost at this farm was removal of wire from the hedge prior to coppicing so as not to damage the chipper, this took four days labour for a 400 m hedge. However, without these additional costs and assuming availability of machines, the larger-scale mechanised coppicing and chipping operation at Down Farm was the most cost-effective (Table 3).

Economics

Table 3: Cost comparison of farm-produced RCW with other sources of RCW/ compost

Input	Costs	Cost/ha	Other costs/benefits
RCW produced from on-farm material			
RCW from hedges	Harvest and chipping (labour/ machinery) Small scale: Chainsaw and hand-fed chipper (£40.50 /m³)	**£2,433**	**Costs:** Land out of production for trees/ hedges **Benefits:** Other ecosystem service benefits of trees and hedges on farm: • Improved management of trees and hedges • Potential environmental stewardship payments for tree and hedge management (e.g. hedge coppicing grant £4 /m) • Closed system farming - reduced reliance on external inputs • Potential for additional income from firewood or other tree products • Reduction in annual hedge flailing costs of up to £0.25 /m
	Large Scale: Tree shears and crane fed chipper (10.75 /m³) excluding machinery haulage	**£645**	
RCW from SRC agroforestry	Medium scale: Tractor mounted circular saw and hand fed chipper (£33 /m³)	**£1,986**	
Compost produced from delivered in material			
Woodchip compost	Machinery and labour to turn compost (£4.40/m³), plus arboriculture chip delivered free of charge	**£264**	**Costs:** Interruption of supply/ issues with quality. Small quantities **Benefits:** May be able to use as RCW without composting
Green waste compost	Production costs (machinery and labour to sort and shred material, turn and screen compost (£22 /m³ based on farm scale operation)	**£1320**	**Costs:** • Land for compost production and storage • Large initial investment in set up costs • Cost of compliance with regulations • Plastic contamination. **Benefits:** • Gate fees from taking in deliveries (@£20 - 40/t) • Potential additional income from sales if compost certified PAS 100
RCW or compost bought in externally			
RCW (woodchip)	Purchase (£18 /m³), delivery (£180 / load) and movement (£45 /load)	**£1,305**	**Costs:** Interruption of supply/ issues with quality
Green waste compost	Purchase (£500 for 60m3), delivery (£180/load) and movement (£45/load)	**£680**	

Notes: Assumes application rate of 60m³ /ha. Future applications may be at lower rates. Excludes cost of spreading. Benefits of all methods include long term increases in SOM and improved soil structure and water holding capacity.

WRAP estimates that the fertiliser replacement value of compost is around £2.75 per m³ of compost[9]. In addition, the long-term improvements to soil organic matter associated with both compost and woodchip can lead to better crop health, potential savings in fuel during cultivations, reduced frequency of irrigations saving labour and water and improved soil structure. These benefits are difficult to quantify but farmers notice them where compost has been used.

It is also hard to put a price on the additional benefits of increasing on-farm tree cover or conversely of the potential damage to the environment of excess use of mineral fertiliser.s But even without these costs the summary figures presented in Table 3 show that where there is a ready supply of woodchip available (e.g. from local arboricultural activities or from power line clearance), and the space on farm for composting, this is the most cost-effective option. If this material could be used directly as RCW without the need for composting this could further increase the appeal to farmers. This material could then potentially be supplemented with woodchip produced on farm from the management of existing trees and hedges. Scaling up this operation to produce the volumes of woodchip or compost required by larger arable farms increases the cost of production significantly and buying in ready-made compost is significantly more cost-effective even without the infrastructure set-up costs. However, there are potential issues with buying in compost, there is less ability to control quality and you are at the whims of the market with fluctuating prices and availability.

Summary

If making a decision purely on cost, based on the information presented above it is unlikely that a farmer would choose RCW over compost. However, many factors may make RCW an attractive choice including lack of availability of compost, lack of space for storage or production of own compost and a wish to be self-sufficient in inputs.

The relative costs of different methods will vary between systems and farms, but RCW is likely to make the most economic sense:

- when coppicing to rejuvenate an old hedgerow,
- where local woodchip supply is limited, costly and/or the quality cannot be guaranteed.
- where hedge or tree management for logs produces brash that will not otherwise be used.

It should also be considered that RCW and compost although both adding organic matter will have different actions on the soil (c/f WOOFS Technical Guide 2) and could be used in a complimentary way.

There are economies of scale to consider in the production of RCW and coppicing and chipping becomes cheaper per unit as the volume increases and contracting in larger more efficient machines becomes viable. However, larger farming enterprises often also have less flexibility to change and adapt as their scale (field sizes, business turnover required) means that doing things by hand or with smaller machinery is prohibitive.

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This work is part of the EIP-AGRI Woodchip for fertile soils Operational Group (https://ec.europa.eu/eip/agriculture/en)

Thanks to the trial hosts Iain Tolhurst from Tolhurst Organics, Robert Benford from Down Farm, Paul and Mark Ward, David Wolfe and the late Martin Wolfe from Wakelyns Agroforestry; other members of the Operational Group Ben Raskin from the Soil Association, William Hamer from Hampshire Woodfuel Cooperative, Christine Watson from SRUC, Nigel Stimson from Tree Shear Services and Dominic Amos from the Organic Research Centre.

Contractor spreading woodchip at Down Farm

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