

Setting up a Wormery on an Organic Farm

Practical Uses and Economics



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Introduction Why a wormery?

I'm an apprentice grower at Purton House Organics in Purton, near Swindon. We supply around 250 veg and fruit boxes directly to customers, plus deliver to a few wholesale outlets, pubs and restaurants, and have stalls at some local markets and our own small farm shop. We grow fruit, vegetables and herbs on around 22 acres; plus the farm also includes a suckler herd of cows; and around 350 laying chickens. As a veg box scheme, we have to buy in fruit and veg during the hungry gap for the veg and fruit boxes (and shop), to supplement our own produce. There is of course a lot of veg waste left over from the shop, polytunnels and field (some waste goes to the cows, or chickens); as well as paper and cardboard. Much of the bought-in produce comes in cardboard boxes, which the wholesaler is not keen to take back (unless in mint condition); and we also have a lot of soiled cardboard egg trays and boxes from the chickens (and some old or smashed eggs), plus ruined veg boxes – and all this cardboard needs disposing of. Previously the flattened cardboard has either been used as a mulch between the eight polytunnels, or around the orchard trees, or burned; yet there always seems to be more piling up.



We've been planning a proper compost system since I first came to the farm, but the materials and time to finish a proper heap system have not yet become available. However, we've heard of some successful wormeries used by small growers; and most importantly they can in theory cope with huge amounts of waste and cardboard, quickly and efficiently. My employer, Rowie Meers, was especially interested in finding out more about these worms, and thought it would make a good addition to the farm, and an interesting talking point for open days.

Hearsay anecdotes from other growers have also suggested that worm compost is excellent for sowing or potting compost, which was especially interesting for the farm, as currently we spend around £1,000 a year on compost to raise our own module-sown transplants. Economic conditions being what they are, we were also keen to reduce our dependency on buying-in transplants, so any help in raising our own modules and providing more reliable transplants would be helpful. So I wanted to find out what setting up a wormery entailed, how successful it would be, and whether it would be the best way of disposing of our green (vegetative) and brown (cardboard and paper) waste. 'Best' could be defined in a number of ways, but I'll be looking at four inter-linked main areas: whether it will be the 'best' in terms of raw economics, i.e. the cheapest solution; in terms of effort and resources (though this could perhaps also be boiled down to money as well, as paid man-hours); in terms of end product for the soil and whether there's any improvement on crop yield from the worm compost; and in terms of most efficient use of raw materials – that is, meaning the least waste of nutrients and so on, leading to a smaller need for off-farm inputs (which could again come down to money rather than the philosophical self-sufficiency angle).

Research: getting started

It's fairly easy to find out information about small domestic wormeries, with many on-line companies and even farms now supplying both worms and small wormeries. However, after talking to worm company Bubble House

Worms, we realised that a large custom-made wormery would be the only practical option for us, unless we wanted to spend lots of money on a larger series of fiddly smaller wormeries. For example, Worm City's largest wormery is a 75 litre chest with a sump to collect the worm 'tea' or rich liquid that runs from the compost, and costs £87 plus p&p each – we'd fill that quite easily within a week, so would need at least 12 as the earliest we can empty a wormery would be after three months. If we went for that option, it would cost us over £1,000 just for the wormery. Therefore, a larger homemade receptacle would be needed.

I visited Bubble House Worms in May 2009 and had a look around their site, where as well as selling the usual domestic plastic or wooden wormeries, they breed worms in their own homemade wormeries. These wormeries were much larger than the household worm bins: they were rectangular wooden structures about 80cm wide by about 2m long, and about 50cm high; with custom-made wooden lids to keep the worms dark and damp, and deter birds and other predators. Each wormery was divided into two sections, with a panel slotted across the long box in the middle, widthways, creating two similar sections approximately 80cm x 1m. This meant that they would add waste to one half of the wormery, then once that was full up, leave the worms to get busy digesting it, while they filled up the other bay with waste. The idea was that once the second bay was full of waste (this took them from three-six months, depending on time of year), you could go back to the first bay and start removing the crumbly compost, and begin filling that section again. This meant that there would be no need for turning the compost as the worms would break down the entire section, unlike a regular compost heap. Under ideal conditions, worm castings or compost are ready to be used after about three months of digestions; though you can leave them longer for a finer compost as the worms will continue to digest the castings already there, until the resulting compost is that ideal brown friable substance.

Bubble House reckoned that for our amount of green waste and cardboard – we estimate it to be around 20kg of green waste and 10kg of cardboard and paper a week – we'd need 30kg of worms (under good conditions worms can eat up to half their body weight per day). They recommended that we should start with 20kg, as the worms would reproduce quickly to make over 30kg (they become sexually mature after just 8-10 weeks). And when it came to size of wormery, Woody and Sheila at Bubble House suggest a minimum of a square metre of ground space per 10kg of worms, or a square foot of space per kilo of worms.

They wouldn't be any old earthworms that happened to slither along either: the two sold by most worm producers are *Dendrobaena venata*, which can live for up to 15 years, and *Eisenia fetida* (Brandling or Red Wiggler worms). Both are epigeic worms, which means they live on the surface of the soil, and can be found in the rotting leaf or vegetable litter layer, eating detritus. They're not great just in soil alone, as they can't dig very well, and need good aeration and food sources around them; they can tolerate slight fluctuations of moisture content, but like most worms prefer it damp and dark.

In June we decided to go ahead, and ordered the 20kg of worms from Bubble House, at a cost of £400 (£20 per kilo, sadly no discount for bulk buying). We checked with the Soil Association to see if we needed a derogation to get the worms in, as Bubble House are not certified (though they follow organic principles); fortunately the Soil Association told us there would be no need for a derogation or any quarantine. Bubble House had also suggested that wastes should be shredded before being presented to the worms, or they would take much longer to break down and turn into compost. We didn't have a shredder at Purton House, so started looking into buying either a garden shredder or larger expensive PTO machine that would fit on the back of a tractor. Eventually, for convenience and economic reasons, we decided to go for the same model that Bubble House themselves used: the Rover Chip'n'Shred, which had an RRP of around £600 – but we managed to find a deal on-line to buy it new for £300. Meanwhile, we needed to start building our own wormery.

Building the wormery

Following the inspiration at Bubble House, we used two large old wooden potato storage boxes, which are approximately 1.2m x 1.8m, and 0.8m high. These were so old that they didn't have any bottoms; which would be good for draining the excess moisture away, but meant that the worms could disappear downwards, or that other creatures and predators could burrow upwards. Bubble House had suggested covering the bottom with a membrane, then putting gravel on top, before adding food/bedding and the worms. This will prevent the worms from exploring too far, and deter predators such as moles from breaking in. We therefore placed a long

strip of Mypex (permeable woven polypropylene membrane) underneath the two boxes which were placed side by side, to create a long wormery, and stapled the Mypex tightly to the outside of the boxes (rather than the inside, thinking that the worms would break out down the creases if the Mypex were folded inside, and creatures could get in the same way). We then added a bought-in bag of coarse sand (this is also useful in the wormery anyway as worms swallow sand to help crush their food), and gravel to the bottom of the boxes. This should mean that excess liquid could drain away well. We then drilled holes in the potato box walls that were touching side by side, so creating a way for the worms to pass from one compartment to the other.

We'd decided to create four compartments, as we thought that would work better than two: we could fill one with waste, then move onto the neighbouring box and so on until all four compartments were full. Then we could start from the beginning again once we'd removed the old compost from the first compartment and used it, and so on. So I found two old pieces of thin plywood board that had come as pallet dividers from our wholesaler, which already had some large holes in them, and we drilled a few more lower down before sawing the boards to size, and wedging and nailing the two of them in place in the wormery to make four compartments.

This just left the lids to make, which we made from lightweight pallet tops, again already to hand as they had been used as pallet separators by the wholesaler. We covered each of these with more black Mypex to create a water-permeable top that would keep the wormery dark, and birds out (we also thought that the black would help keep the wormery warm, as worms prefer temperatures between 8-25°C). As these lids were light, we also had some left over fence posts handy to weigh them down when it got windy (and also keep the Mypex from blowing off the frames). The wormery was then all ready for when the worms were delivered a couple of weeks later, in the middle of July.



Once the 20kg of worms were delivered, we placed them into the first two compartments, rather than just the first as planned, as there seemed to be too many to fit into just one compartment. However, we still planned to add new waste to (mostly) one compartment at a time, for a few weeks or until it was full up, and just give the worms in the other compartment a head-start. So we added some shredded cardboard and a basket-full of waste to the compartments, and let them settle in. Woody from Bubble House had also suggested covering the heap in each compartment with a damp large piece of cardboard or flattened box, to provide extra shelter for

the worms, and encourage them to work near the top of the pile, as it was so shallow to start with. We carried on the practice keeping this extra 'lid' in each compartment as they seemed to enjoy it, and it was a quick way of checking on the worms – just lifting the cardboard and seeing them underneath.



Maintenance & feeding

From the moment we got the worms, they were very low maintenance. We'd previously shredded a load of rain-soaked or hosed-down cardboard with some green waste together, (it helped the shredder cope with the tough cardboard if it was wet and churned up with green waste), and kept it in a large dumpy sack. When this ran out, we shredded a load more; though this had very little green waste in it.

On average I'd add a barrow-full of this mixture to the wormery every week, and any suitable small green wastes such as thin leaves went in too; I'd add water if necessary in hot weather too as the added cardboard was often dry if it had been left in the sun. As is often the case with holdings that see a large number of workers come and go (volunteers, work experience pupils, seasonal staff), I'd sometime find some strange things in there, including rotting fruit, smelly old eggs, straw, dusty shed sweepings complete with elastic bands and plastic bags, and mouldy cooked food scraps. However, apart from attracting small fruit flies and a few other apparently harmless insects, the worms didn't seem to suffer much (once the non-compostable items were removed). I've found out since that the general advice to avoid citrus fruits (and some recommend leaving out pineapple and onions too), because they can acidify the mixture too much – worms prefer a pH neutral home. However, all the smashed eggs there probably counter-balanced any acid additions.

It took around four or five weeks to fill up each compartment initially; though when checking the original compartment at the end of the cycle, the mass of waste had dropped considerably, and there wasn't much compost to show for it, so we started the round again – therefore leaving it about eight months before harvesting any compost. However, the compost was ready before this time to use – but we were not; and as I knew the compost would only get better the longer it was left, we waited until we had some plants to pot on before using any. Some of my diary extracts are detailed below:

Wednesday 22/7/09

Fed new worms a barrow load of cardboard and bits of green waste, they seem to be settling in, though some are climbing up the damp sides of the wooden box?! Hope they change their minds and go back down, rather than escape.

Friday 24/7/09

Finished the final partition for the last two compartments of the wormery, and gave them a bit more pre-shredded mushy cardboard food. Think they're OK – could find them easily under the cardboard.

Thursday 13/8/09

Put a few worms in the last two compartments to get things going, in case not many find their way at first through the drilled holes. They're all hiding now!

Thursday 12/11/09

It looks like we have some worm compost! Put four boxes-full of cardboard and two boxes of mashed up green waste in two far compartments, but found what looks like a rat or mouse run in some semi-dried cardboard, argh! Added lots of water to make any rats want to move home.

Tuesday 19/1/10

Found a mouse in the wormery while adding food! Cheeky thing, maybe it's that instead of rat which has the burrow. Don't think it eats worms, and it's very icy now so may leave it. Must have chewed through the Mypex underneath as can't see how it got in; or climbed through tiny gap between side and lids. Has helped break potato chunks down though!

Monday 29/3/10

Emptied last of the dumpy sack of shredded cardboard into wormery - also took first half barrow-full of compost out of the first compartment, and left it in shed in the barrow and cover with a paper sack so worms can gather and hide underneath, leaving relatively worm-free compost elsewhere. Mr Wormery Mouse winked at me again.



One new addition this year (2010) has been planting comfrey around the wormery. We ordered 12 cuttings from Tamar Organics in the spring, and planted them at the base round the back and the sides, but not the front as we thought this would impede feeding. The idea is that as we don't have a method for collecting the nutritious 'tea' from the worms, the comfrey could do the job for us. Then if we want to make some nutrient-rich liquid feed at some stage, we can cut the leaves and after leaving them to rot down in a bucket, feed the worm's liquid waste indirectly back to whichever plants we choose.



Pests & problems

The main problem we came up against once the wormery was installed was that our shredder stopped working in the winter of 2009. A friend of Rowie's took it away to fix, but then borrowed it for some time, and we didn't get it back for quite a few months – until late spring 2010 (and the ill-fated shredder was then later stolen in August 2010). This meant that the worms' diet was pretty limited, as we used up the pre-shredded cardboard and waste paper or small card pieces, and could really only add smaller pieces of veg waste. Most of the green waste from that time of year (cabbages, potato and so on) went either to our new regular compost system (a large muckspreader which spun the filled-up trailer-full of waste out the back); or to the herd of cows. Therefore the poor worms were usually third-choice for waste products as without the shredder it could be time-consuming to sort suitable waste for them.

The mouse didn't seem to cause too much of a problem, and seemed to help break down the potatoes and cardboard by chewing too; though large numbers would be worrying as the wormery is fairly close to the veg shed. Keeping the waste damp or wet (but not dripping) can help put them off.

Insects have moved in as well, such as slugs, earwigs, beetles and woodlice; but again, they don't seem to affect the worms much. Wasps and fruit flies are more annoying than anything; and in the summer of 2009 we were worried that wasps might be checking out the wormery as the ideal place to start a nest – but again, keeping everything damp and any fruit waste well mixed with other waste, particularly cardboard or paper, seemed to deter them from doing so (touch wood).

Other wormery owners have reported small crawling white 'insects', and ours has plenty too: they look like common white spring tails – cryptozoa (humidity-lovers) which are especially common in compost heaps or leaf litter, and are detritivorous and microbivorous, so help in the general break-down. This again is no bad thing, as the worms will eat their waste products too.

I have found some odd faeces in the wormery recently (July-August 2010) which looks too large and long to be

rat or mouse poo: though is a possibility that it might be a stoat or weasel of some kind as there has been a sighting about 200m away in the chicken house. Weasel nests are made from grass and leaves, so they would probably feel at home in a warm wormery; and their diet is mostly made up of small mammals like mice and rats. This could mean that if the poo does indicate a weasel of some kind is getting in, they are sorting out any mice themselves. Hopefully the way they got in (this must be underneath the wormery) is not so large that all the worms are disappearing down there and slithering to freedom... One way to make sure will be to keep the food/bedding levels high, as they will naturally move nearer the top to feed. So far there still seem to be plenty of worms in the wormery anyway; when it comes to clearing the worm compost from each compartment, I will see if I can check the bottoms of each section, to see if I can find any holes (and weasels).



Soil analysis & compost uses

As we were sending samples of soil from around the farm off to be tested for nutrients in March 2010, we sent off a sample of around 300g from the worm compost too, on 19th March, to NRM labs (£45 per full analysis). The results came back about a month later, but were difficult to work out – it turned out that they had been incorrectly tested as an inert medium, rather than as a compost such as manure; so we sent another sample to the lab for them to test on 18th June, free of charge.

The results were emailed back on 1st July, and were as follows – showing the amount at an equivalent total nitrogen application of 170kg N/ha (total compost needed would be 33.21 tonnes per hectare or 9,497kg dry matter):

170kg Nitrogen (N)
15.99kg Nitrate Nitrogen (NO₃-N)
72.64kg Phosphorous (P₂₀₅)
79.66kg Potassium (K₂O)
76.46kg Magnesium (MgO)
102.09 Sulphur (SO₃)
0.52kg Copper (Cu)
1.11kg Zinc (Zn)
12.67kg Sodium (Na₂O)
736.42kg Calcium (CA)

The main comparison points with manures, according to the analysis, are as follows:

- Worm compost (WC) has more dry matter (and therefore organic matter potential) than cattle FYM and pig FYM; but less than laying chicken, broiler chicken/turkey and duck manures.
- WC has less N (5.12kg/ton) and ammonium nitrogen than other manures (not very surprising as worms don't urinate).
- WC has less P (2.19kg P₂₀₅/ton) and K (2.40kg K_{2O}/ton) than manures.
- WC has much more MG (2.30kg MgO/ton) than cattle and pig manure, less than broiler manure, and just a bit more than layer manure.
- WC has more S (3.07kg SO₃/ton) than most manures except broiler/turkey manures.



Trace elements like copper and boron are also low or very low, according to the table of tolerance levels for trace elements, in Soil Management of Organic Farms technical guide (p19). This is at first glance surprising, as the only inputs aside from cardboard and paper would be green wastes that had sufficient levels of trace elements in. However, partly due to the absence of the shredder, much of the input was in fact paper-based rather than green, so very low in nutrients. It would be very easy to add more green waste to the wormery. As well as the soil analysis, we also trialled a practical test of the compost. We took out a wheelbarrow-full of compost from the first compartment in March 2010, to mix with our regular bought-in potting compost (either Fertile Fibre or West Ridings compost). The plan was then to compare the potted-on plants in the mixed compost to those which just had the regular compost.

We tried this out, very roughly and not especially scientifically, first of all to see if the worm compost hindered young plants in growth, and secondly to see if it could actually help by boosting growth and providing a few more extra nutrients. Test plants included sweet peppers and aubergines. The worm compost looked great, nice and crumbly, and as written above in the diary, I left a sheet of damp newspaper over the barrow, so that most of any worms still in the compost would hide underneath, so could be collected easily and returned to the wormery. Then the next day I potted on the plants, using between a fifth and a third of wormery compost to normal compost in the test pots. I then labelled those pots with 'WC' so we could keep track of them.

When we were ready to plant the peppers and aubergine out in polytunnels, we compared the test pots to the other plants. There wasn't too much difference between them on the whole, which was good on the one hand (the worm compost didn't hinder growth), but didn't prove conclusively that it was a major benefit. However, a few of the WC Corno di Torro pepper plants seemed to be up to 2cm taller than the normal Corno di Torro counterparts, which looked promising (below WC plants left, normal compost right). We planned to keep an eye on where the trial plants were in the polytunnels, so we could also compare crops and so forth. However,

the entire tunnel of sweet peppers succumbed to a terrible attack by aphid in the early summer, and never recovered. It would be nice to say that the WC plants withstood the attack, but the damage was very steady as the aphid progressed from one end of the tunnel to the other. The ladybirds did eventually come in, after a couple of sprayings with garlic mixture (which didn't seem to do much); but for many plants it was too late. The plants at the end of the tunnel suffered less, and produced pepper plants; but were a mixture of trial plants and normals. It's therefore quite difficult to comment on the effect of WC compost on plants long-term; at the very least they don't harm the plants, and there is a little evidence to show that it can give an early boost too. Our aubergine plants also got a little bit of aphid, but later than the peppers, and not as severe. Unfortunately the labels from the aubergines got mixed up in the planting (another problem when a number of people and volunteers work at the holding), so it's difficult to draw many definitive conclusions from that – except to say that the crop as a whole has been excellent this year and is still fruiting well into late September.



Conclusions

Ideally, the worm project would be carried out differently if I had the chance again, and more time. As well as running more useful and controlled experiments, I'd make sure that the worms were getting plenty of green waste too, and we're adding lots more now to the wormery, even without the shredder (they like old teabags, salad, spinach and chard leaves plus some 'wet' weeds, which are easy to put in). The worms also get leftover cooked food very occasionally, from a catering business run from the farm.

Considering the lack of green waste that went in the compost, the analysis showed a surprising number of nutrients. There was a good level of calcium too, which we expected, as worms cover their castings or poo with calcium (Ca) in their stomachs. There was also a good amount of Mg too; and as both Ca and Mg are cations, they are very useful for holding onto other nutrients in the soil. Ca can also help push the pH of a soil up, which is useful when soils become acidic (especially useful when growing species which prefer less acidic soil, such as peas and most other market garden crops).

At first I thought that a wormery would be a very expensive way of producing something either to improve the soil, or to add to potting compost: but actually the capital costs are much lower than many composting systems, and the running costs are also low.

Capital Costs

Worms £400

Sand & gravel £10

Shredder £300

Total capital costs: £710

Running costs

Petrol (approx 1-2 litre/hour @ an expensive estimate of £1/litre) so 6 hours hard shredding = £6-£12

Actual official man hours: 10 @ average of £7/hour: £70/year

Estimated minimum unofficial (unpaid) man hours: 30 minutes/week or 26 hours/year

If made official manhours @ average £7/hour: £182/year ongoing costs

(Note: manhours on shredder can be tied-in with other jobs such as keeping an eye on the farmshop, so proving more economical)

Total running costs: £364

Total cost for first year: £710 + £364 = £1,074

For this amount, we estimate that the worms have produced perhaps around 4-8 barrow-fulls of compost per apartment (the longer we leave it in, the less mass it has), and (perhaps more importantly) disposed of something in the region of at least 12m³ of flattened cardboard, and the same amount of veg waste. So while for your £1,000 you might only get 32 sacks of (very fertile) compost in the first year, (£31.25 per sack), you're also getting rid of the problem of waste. This is very low productivity though, and once in the rhythm we could easily quadruple the end compost amounts with little extra work (though getting the shredder back would help!). This would mean up to 128 sackfuls of compost next year, at a running cost of around £400 – so just over £3 a sackful. This is much better than even the £5+ per bag costs of commercial bulk-bought compost – and we're getting rid of waste at the same time. Rowie estimates that she spends £1,000 a year on compost (up to 200 sacks). While worm casts would be too potent to replace bought-in compost altogether, if we used only 1 part wormery compost to 3 parts bought-in, we'd still save £2 per sack on 50 sacks – £100 per year. We would also be more self-sufficient, and be recycling more nutrients.

It would also be useful to compare the wormery in terms of efficiency, nutrients, speed and costs to a regular hard-working compost heap, which we hope to have up and running by 2011. When compared to composting systems such as Controlled Microbial Composting (CMC), the wormery looks pretty good. According to the Compost The Microbial Way fact sheet, this involves using a starter culture of microbes and to keep the temperature stable, compost laid in windrows will need turning once a day to start with, then once a week. As the temperatures can reach so high, there is also a danger of ignition if not managed correctly; and much care is needed when creating the layers of wastes to create the right conditions. The figures quoted for turning equipment are between £8,000-£1000,000, plus establishing the hardcore base, the covers and man hours involved. Whilst this might be a good option for large operations, for small to medium-scale growers, worms can be an effective solution to waste. In terms of beneficial microbes, worms house many of these in their gut, so proliferation of worms means more helpful microbes which help breakdown pathogens and harmful bacteria – without the need for extreme heat. However, worms don't tend to destroy weed seeds, so it's important not to include those in their food or bedding.

In terms of the original question, it seems that a wormery could well be one of the 'best' disposers of waste. Our wormery was relatively cheap – not as cheap as just leaving all the waste on one heap, but that would make poor compost and waste lots of nutrients. Any man-hours used to turn heaps and maintain them properly would mean that wormeries are not much more expensive (if at all). In terms of resources and effort, they are very low-maintenance, and just require food as and when you want to get rid of it (compared to high-maintenance livestock, or a CMC system). In terms of end-product, our own version wasn't bad, but could have been a lot better with more green waste. It might have less nutrients than manure, but is much more pleasant to handle as it just smells like crumbly soil; and isn't too N-rich so can be used for sowing and potting, rather than manuring whole beds (though this is possible too). In terms of efficiency of raw materials, it has to be one of the best, alongside pigs, as worms can cope with pretty much anything. Ours got through leek, onion and garlic trimmings quite happily, rotten eggs, leftover paella and thick cardboard, just to name a few.

Overall, I'd say that a wormery isn't the only way to reuse wastes on a commercial growing enterprise of course. However, used in conjunction with other methods of waste disposal, such as livestock feeding and regular 'normal' composting, it can provide a valuable addition – and has proved a great talking point at Open

Days for visitors. They have also been encouraged to make their own smaller versions at home, to recycle their own food wastes – so worms can even help with the wider problem of waste in this country. Not bad for a creature that is only a few centimetres long.



Resources

- Bubble House Worms
Bubble House Worms
Chapel Lane,
Bransford,
Worcestershire.
WR6 5JG
Tel: 01886 832559
www.bubblehouseworms.com
- NRM Labs (analysis)
Tel: 01344 886338
www.nrm.uk.com
- www.wormcity.co.uk
- www.scottishworms.com
- www.working-worms.com
- Soil Management of Organic Farms
Soil Association Technical Guide
- Compost The Microbial Way Soil Association Briefing Paper

Lucy Rees, Spring 2007

- Beneficial Soil Microorganisms

Dirk W. Muntean, M.A., Consultant, Soil and Plant Laboratory Inc., Bellevue, WA

- The Formation of Vegetable Mould Through the Action of Worms

Charles Darwin, Echo Library 2007