



Designing an Aspen Agroforestry Scheme

Eadha Enterprises

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Introduction

There has been renewed interest in agroforestry in the farming sector, with benefits being recognised of increased sustainability and productivity. This interest is anticipated to increase with CAP reform and anticipated new support for such systems. This coupled with new highly reputable research in Scotland, Northern Ireland and Wales which has confirmed that there are increases in forage and livestock production (shelter, frost protection, drought protection, shade) in the agricultural component of silvo-pastoral systems under UK conditions (Agroforestry Trust), has made it even more of an attractive option for land management. Many farmers like trees, but hate loss of agricultural production. New support through SRDP will mean that the Single Farm Payments will be maintained in agroforestry systems.

Aspen is most suited for use in an agroforestry/wood pasture system as it is a fast growing native species and casts a light shade compared to other species. In addition it can deliver a range of other specific benefits as detailed below.

Eadha Enterprises is working with landowners to develop aspen agroforestry schemes which will replicate a traditional wood pasture system using native aspen on upland pasture and exploiting the benefits of aspen to stabilise soils, neutralise soil chemistry, and provide a biomass crop for use as supplementary fodder for livestock, in on-site biochar manufacture and/or as woodfuel.

Aspen Project

Eadha Enterprises is a social enterprise with charitable status supported by both of Oxfam and the Scottish Environmental Technology Network (SETN). Eadha's main focus has been in developing a native aspen conservation project and researching and promoting the use of aspen in productive forestry and community woodlands.

Aspen is nationally rare and of conservation concern. It rarely sets seed and historically there has been very limited planting stock of local provenance available. Eadha has been addressing this by taking a clonal forestry approach to tree production. Eadha has built up a national collection of aspen clones from the full geographical and topographical range across Scotland. Each clone has evolved as a genetically unique specimen with unique growth characteristics and tolerances to different physical conditions. Eadha has developed a stock of clones using vegetative cuttings, propagated by hand in its nursery. However, Eadha also uses a micropropagation laboratory to mass produce stock by plant tissue culture methods. Eadha is developing projects in Scotland to trial native aspen in different environments and under different conditions, and to explore how systems can be designed to integrate productive woodland with other community and amenity uses.

Clones

Eadha has built up the national aspen clone collection for Scotland and can select suitable clones for planting in different geographical areas and topographies.

However another consideration in a productive system is clonal performance and Eadha has some comparative growth trial data which can inform clonal selection based on superior qualities, albeit from a limited clonal mix.

In clonal forestry, it is crucial to create plantings with a sufficiently diverse genetic range and the collection allows a sufficient genetic mix to be selected for projects to create robust and sustainable systems.

Proposed System

Although there have been some agroforestry trials in Scotland over the last couple of decades, notably by the James Hutton Institute (JHI), (formerly the Macaulay Land Use Research Institute), this practice has never been taken up widely by individual farmers and landowners. Wood pasture is a traditional system for which there is evidence across Scotland, and with some remnants still visible to this day.

The typical density of a traditional wood pasture system is 400 trees/Ha (5m centres). In such a system, trees were typically pollarded above browsing height at 3m to produce supplementary feeding for livestock.



Poplar Wood Pasture in Eastern Europe

It would be assumed that pollarding the trees would also promote suckering although the extent of suckering is difficult to predict. Trials in Germany have indicated that where a crop of aspen is harvested (cut at ground level) after 10 years, as much as 45 stems/tree on average can regenerate. This will reduce naturally in more dense plantings through competition to 2 dominant stems from the stump and 3 suckers.

Forage

Aspen has been found to be a particularly nutritious which can form a substantial portion of the diet of both livestock and wild ungulates. Aspen leaves have been found to average up to 17% protein (peaking in June) and fat content up to 10% (peaking in September). The variation in nutrient content between clones, however, can be substantial. The bark and wood of mature aspen trees also has a potential value as livestock feed. Aspen bark is about 50% digestible and aspen wood about 35% digestible. Ground and pelleted aspen wood, supplemented with standard cattle feed, could comprise as much as 48% of the diet of growing cattle without adversely affecting weight gains and meat quality. Aspen pellets made from whole trees also can substitute for up to half of the silage roughage fed to dairy cows. Steam-cooked aspen wood is very similar to alfalfa in energy digestibility, and presumably can satisfactorily replace much of the hay ordinarily used in ruminant feed. Feeding trials in the U.S. indicate that steamed aspen can make up 30% of the dry matter diet of beef steers without adversely affecting gains or meat quality and that up to 30% steam processed aspen chips can be used as a roughage substitute in maintenance rations for mature sheep. In the Nordic countries aspens were traditionally pollarded to supply feed for horses.

Biomass

Based on the findings of Short Rotation Forestry (SRF) trials by Forest Research, the anticipated total biomass produced from such an aspen agroforestry scheme would be in the order 1T to 1.7T /Ha/yr depending on clonal variation. While all the biomass available will not be utilised with pollarding, it gives some idea of the productivity of aspen.

Biochar

In addition to woodfuel and forage, another use for harvesting material would be for on-site biochar. Small scale low tech kilns are now becoming available for farm scale production. Biochar can be used as a soil and growth promoter as well as providing a mechanism to sequester carbon in the soil. Eadha has been undertaking research in partnership with Strathclyde University on the properties of aspen biochar. The results show that aspen char has a neutral pH unlike other tree species such as willow which produced alkaline char which can alter soil chemistry. The research also indicates that aspen char can be produced at relatively low temperatures and still have high absorption properties.

Additional Benefits

Biodiversity

A wood pasture will provide a transition between enclosed woodland and open farmland/hedgerows, providing ecological connectivity. The value of wood pasture is increasingly being recognised in this context and it is one of the Priority Habitats in the UK Biodiversity Action Plan. In ancient wood pasture, stable grazing-maintained plant communities are likely to have evolved with elements of both woodland and open vegetation communities present.

Establishment of an agroforestry scheme would be appropriate adjacent to a moorland habitat where there are sensitive ecological issues such as the conservation of bird life such as ground nesting birds and waders which may have precluded the establishment of woodland. An agroforestry system, is compatible with these ecological concerns as it would not create increased cover for predators such as foxes or nesting sites for crows if managed (pollarding/species choice etc).

Landscape

The open nature of a wood pasture system together with the beauty of native aspen and the variation provided by different clones will deliver a stunning landscape feature (see below).

Flooding

Trees increase interception of rainfall and lead to reduced runoff which has particular benefits on upper catchment areas

A broadleaved woodland will intercept nearly 20% of rainfall. No figures are available for a typical agroforestry/wood pasture system, however adjusting for reduced tree densities the proportion will be around 4%.

Soil Remineralisation

Upland soils in Scotland are typically depleted of nitrogen, calcium and organic matter due to the long term removal of sheep and cattle from the hills and the tradition of droving, with cattle being taken to Scottish lowland and English markets. Furthermore, acid rain has contributed to soil acidification. The role of aspen trees as a nutrient sink for calcium has recently emerged from several studies. Unlike most tree species, it has been well documented that aspen take up large amounts of calcium from the soil pool and retain this nutrient in the perennial tissues of the plant. In addition to calcium, it is also particularly efficient at retaining sulphur, and zinc, especially in the bark, which has photosynthetic capability. Aspen foliage is shed annually, but it decomposes rapidly and tends to be efficiently cycled within the forest ecosystem. It is well known that aspen is one of the key pioneer species however, new research has crystallised this further. For example, it has found that aspen although not leguminous, can fix atmospheric nitrogen. A large community of endophytic bacteria resides in the stem tissue of aspen. Among these endophytes, several diazotrophic (nitrogen-fixing) bacteria have been identified.

Design

It is recommended that aspen clones are planted in discrete blocks to allow for a comparison of clonal performance for the particular site. This will inform future restocking and expansion including other projects in the wider geographical area. The creation of clonal blocks also mimics natural aspen woodland as seen here in the image below where clonal differences create a mosaic of colour throughout the year and can provide an interesting landscape feature (see photo below).

However, for the future survival of this species in Scotland, sexual reproduction needs to occur and new clones created. Surviving clones in the wild are typically isolated (especially in the south of Scotland) and are therefore not given the opportunity to cross-pollinate. On this basis, every new aspen woodland should be seen as a future seed orchard and for this reason we would recommend that perimeter strips are planted in an intimate clonal mix to maximise cross-pollination during a future seed year.



Tree Protection

Sheep

For individual tree protection against sheep grazing, Forestry Commission guidance (Best Practice Guidance for Land Regeneration, BPG Note 12) suggests that for regular grazing, 1.8m height tree guards are used with two stout posts. However, consultation with the James Hutton Institute who manage the Glensaugh Agroforestry trial in Perthshire successfully used 1.2m tree guards with a single stout post (roundwood sheep stake) in tandem with a single standard tree stake.

At Glensaugh, the tree tubes were replaced with tree netting once the trees were well enough established to support the netting and without bending to the weight of a leaning sheep. For the aspen this would be between 8 and 10 years. At this time the trees would likely fill the tubes which can trap moisture and cause rot. They would need to be removed at this time anyway.

Maintenance is the key for an agroforestry system to be successful. However in this time the stakes may be susceptible to breakage and rot and will therefore need to be monitored and replaced on an ongoing basis. Protection from sheep would also protect against any Roe Deer incursions without the need for a perimeter fence.



Trees with netting at Glensaugh (JHI)

The fence posts are likely to be in good enough condition to be reused for the netting without the need for additional stakes.

Cattle

According to BPG Note 12, individual tree protection for cattle would require 1.8 m high steel netting with 2–3 stout stakes which would render this unviable other than for specimen trees. The JHI advised that at their research station, cattle were only introduced once the trees were well established at about 20 years of age. It is recommended that a similar approach is adopted.

Harvesting Regime

The management regime to be adopted very much depends on the landowner's priorities. There will be a trade off between cutting regularly (every 2-6 years) to promote leafy growth or less frequently (8-15 years) to promote woody material for biomass use assuming fuel logs rather than chipping are desired.

For biochar use relatively thin branches would be required which would necessitate a regular harvesting regime (every 2-6 years). Biochar would need to be cut in the winter before the sap has risen as opposed to summer harvesting for fodder.

For fodder (dried leaves and bark), small branches would need to be cut in late summer and stored over winter. Trees can be designated for different uses or alternatively, different pruning regimes trialled on a single tree to provide for a range of uses. For example, side branches could be removed on a 2-6 year rotation leaving a leader to be harvested on a 10-15 year rotation for biomass to be cut in winter. (In Norway branches are harvested on a 5 year cycle to be dried for forage.) This would mimic the traditional "Shredded Tree" variant of pollarding practiced in medieval times where side branches are repeatedly cropped leaving a tuft at the top to provide forage, and timber.

For timber and/or woodfuel the trees can be felled (coppiced) on a 10-15 year rotation. Once the tree protection infrastructure is removed it is recommended that trees are manually felled to avoid the use of heavy machinery which may damage the pasture. Timber can then be removed by heavy horse to minimise impacts. Tree protection infrastructure would then be replaced to protect regrowth. On average, two shoots are likely to regrow from each stump. After a couple of year's growth the weaker of the two should be cut, leaving a single stem.

It is recommended that clonal blocks are harvested on a rolling programme to provide a continuous supply of product. This will also maximise biodiversity value. If there is a plentiful supply of labour including volunteers, it may be appropriate and viable to consider hand pruning. This would be a low impact method (see photo below).



Pruning by hand (JHI, Glensaugh)

Pollarding will promote suckering, however, without protection, any sucker growth will immediately be grazed by livestock and will not regenerate. To protect suckers, temporary fencing would need to be erected. It would be cost prohibitive to fence a sufficient area around each individual tree. However one option could be to rotate temporary fencing around discrete clonal blocks. This fencing would be provided in addition to individual tree protection and erected following the installation of the tree netting, whereby selected fence posts supporting the tree netting at perimeter trees within the block could be utilised saving any additional fence posts. In conjunction with pollarding, the temporary deer fencing could be rotated block by block every 3-5 years and erected around each new block following pollarding. Redundant tree guards or netting could be reused for protection of selected suckers for growing on for timber or to replace any losses of the original trees.

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