Silvopastoralism using tended poplars on New Zealand hill country: The opportunities

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Abstract

The view of the presenters of this paper is that more trees need to be integrated into New Zealand farming systems. This is particularly relevant to some 3.7 million ha of North Island hill lands that require significant soil conservation measures. Trees have numerous benefits beyond soil conservation and these are outlined. The simplest and most effective means of implementing a large scale strategy of tree planting on land dominated by livestock farming enterprises is likely to be through the use of wide-spaced tended poplars. It is our perception that the full range of benefits (and costs) is not well appreciated within the industry, and so we have attempted to summarise and discuss them here. We have adopted the perspective of the individual farmer, who in the end is the one who will determine the role of trees in the rural landscape.

Keywords: conservation, hill country farming, landscape, poplar, silvopastoralism, soil conservation

Introduction

Few will disagree that more trees need to be integrated into New Zealand farming systems. This paper looks at a particular system that integrates trees into a livestock enterprise. It has a vast potential for application over our hill country that, for various reasons, is likely to remain in pastoral usage, but is of a contour unsuitable for cultivation. The philosophy of integrating trees into livestock enterprises is aimed at the livestock farmer, rather than the farmer with an interest in trees, that is, at a farmer whose aspirations, skills and perceived future are those of a livestock producer. The tree, with all its benefits, is subjected to the livestock enterprise. This presentation is primarily based on the practical experience of 35 years of poplar cultivation on my own and neighbouring properties at Hautope, east of Waipawa, Hawke's Bay and on research work being undertaken by my co-authors.

We suggest that the opportunities available from silvopastoralism, based on tended poplars at medium-to-wide spacing (10–80 trees/ha) over productive pasture, have not had the recognition and uptake they deserve. The criteria below outline why poplar is the most suitable tree for silvopastoral systems, from which the major income will be from livestock.

1. Pasture utilisation (at least with sheep) can continue without interruption while the poplar trees are established. The farmer cannot concede 2–4 years grazing while the trees grow above the browsing reach of sheep as interruption would not only mean a loss of productivity, but would also lead to pasture species deterioration and weed infestation (Gillingham *et al.* 1976). Individual tree protection from browsing allows grazing to be uninterrupted during the tree establishment period. Species that propagate *in situ* from a pole, require less elaborate and cheaper individual protectors.
2. Pasture production loss can be minimised as the poplar tree approaches maturity with development of the large canopy. This deciduous tree allows light penetration to pasture to be maximised for at least 4–5 months of the year.
3. The wide-scale application of silvopastoralism needs to be within the means of the average hill country farmer in terms of finance and time. Poplars can be established and protected at a low cost (Stace 1996) relative to high-value trees such as oak. While oaks do have a place in silvopastoral systems, especially on our better hill country, their role will likely be more specialised and they will be adopted only by the enthusiast.
4. This paper focuses on silvopastoralism from the perspective of livestock production, and includes a brief discussion on the role of planted trees in soil conservation (including both protection and restoration), their fodder value, their provision of shade and shelter, and their impact on amenity and general landscape values. An additional and significant benefit of silvopastoralism using poplar is the prospect of a timber crop at tree maturation, especially if the potential of poplar timber is

developed in New Zealand. With its excellent form, even in an open-grown situation, poplar is the logical choice for future silvopastoralism.

While willow also meets all the above criteria, and is used to a limited extent for timber production in some countries, the genetic stock available here is unsuitable for timber. However, willow does have a key role to play in New Zealand pastureland for erosion control especially in wet, hard or windy conditions. Furthermore, through pollarding it has the potential for the provision of quality fodder during drought.

Costs of poplar in silvopastoral systems

1. Costs of establishment

A poplar pole costs between $2.50 and $7.00. The range is due to cost differences in the size of the pole, variety, protective sleeve used, and distance from the nursery. In addition, there is the cost of planting, although most farmers do that themselves (Stace 1996). This cost (to the landowner) may be offset partly by grant assistance from Regional Councils, many of which offer significant incentives for approved planting. Establishment rates can vary from virtually 100% to almost complete failure. In my experience, a serious failure can occur about once a decade. For a farmer not committed to the concept, this can cause a loss of confidence and a discontinuance of plantings. This is a pity, as usually a poor year is followed by a good one. When dumped from a horse one must immediately remount! For this reason, it is important that there be commitment to an annual programme of planting, which should be viewed as a routine farming practice, regardless of discouraging setbacks. An investment in trees requires a long-term perspective, and progress should be seen in the context of decades. It is also important to note that there is no land cost. This is carried by the core economic activity – a stand-alone livestock enterprise.

2. Loss in understory pasture production

The effect on pastoral production of a wide to medium spaced (10–80 trees/ha) poplar regime is the subject of increasing scientific investigation (Guevara-Escobar *et al.* 1997; Wall *et al.* 1997). Obviously, the effect of changes to the microclimate, water balance and soil properties will have an effect on pasture productivity (Guevara-Escobar *et al.* 1997). Indications are that there will be little or no effect over the first third of the trees' rotation (10 years), perhaps a modest impact in the middle third, and a reduction in pasture production of between 20 and 40% over the final period when the canopy is fully developed (Guevara-Escobar *et al.* 1997; A. Wall pers. comm.). This reduction (0.67–1.33% p.a. over 30 years,) may be less than that caused by erosion if the tree were absent.

With wider-spaced planting regimes, it is unlikely that there will be full canopy closure, but two practical suggestions that will reduce shading and improve potential timber value are:

- that varieties with an erect form be used or further developed. While poplar has a naturally erect and apex-dominant form, two varieties superior in this respect are Kawa and Crowsnest.
- that side-branch pruning be carried out in accordance with accepted silvicultural standards. This also facilitates better stock supervision and management, and provides some supplementary fodder in summer. However, the effect of branch pruning on the soil conservation properties of the tree requires further research.

Benefits of poplar in silvopastoral systems

1. Soil conservation

The traditional reason for over-paddock establishment of poplars was hill stabilisation and the conservation of soil which also protected down-stream land, wetland, and waterway systems. According to Eyles & Newsome (1992), over 7 million ha of New Zealand requires significant soil conservation measures in order to be physically sustainable. Of this area, 3.7 million ha is in the North Island. In the late 1960s through to the early 1970s, tree planting was carried out on an ever-widening scale, until the arrival of poplar rust brought about a hiatus in plantings while new varieties were developed. In recent years, the planting rate has been slowly increasing, but it still falls well short of the pre-rust levels when poles were much cheaper and more generous grants were available (van Kraayenoord 1993).

Several aspects of the interaction of poplars with soil stability, structure, fertility and pH need to be considered.

- It is difficult to define objectively and in financial terms the value of our productive soils, but we know that they are irreplaceable. We have an individual and collective responsibility to protect our productive soils for both economic and ethical reasons. Poplar planting over pasture has a well established record for soil stability enhancement as, in addition to subsoil stability, the maintenance of a strong grass sward has the potential to minimise surface erosion (Hicks 1995).
- Soil fertility patterns are likely to be affected by a spaced planting regime, particularly via the

contribution that poplar leaf litter makes to soil fertility. Specifically, the concentration of calcium is increased in the topsoil stratum as is soil pH, by 0.5–1.0 unit under poplars, with the effects occurring 5–10 years after planting (Guevara-Escobar *et al.* 1998). There is also the issue of maintaining a better distribution of fertility through the provision of shade throughout the paddock, rather than in specific positions as planting trees in blocks (e.g., a shelterbelt along the edge of a paddock) leads to stock and fertility concentrations in confined areas (Hawke & Gillingham 1996).

2. Fodder (prunings and leaf fall)

Poplar leaves constitute a feed of moderate quality as they have an average *in vitro* digestibility of dry matter (DM) of 65% and a metabolisable energy content of 10 MJME/kgDM (Guevara-Escobar 1999).

Leaf material contributes to the fodder pool in two ways.

- *Pruning.* This will necessarily be limited and only be carried out in a way that promotes rather than detracts from tree form. Furthermore, it should only be done in the first 10–15 years of the tree's life depending on the extent to which the farmer wants to tend the crop. In times of drought, where other options (feed acquisition and/or selling stock) may be costly, higher pruning rates may be economic. Certainly, the best way to minimise coppicing from wounds, a problem with poplars, is by pruning in high summer.
- *Natural leaf fall.* This offers much greater potential for an economic contribution to the fodder supply, because it is free and greater volumes will be available as the tree grows, thus compensating somewhat for declining pasture production under the trees. Leaf fall of 3.1 tDM/ha from widely spaced (37 stems/ha), mature (>30 years) poplars has been measured in the Manawatu (Guevara-Escobar 1999). Naturally, the stockman has no control over the timing of this fall, but at times of drought when pasture availability may be critical, the tree will shed leaves prematurely as a defence against transpiration loss. From my observation in the central Hawke's Bay, this can occur from late January through to May where there is a mix of poplar varieties.

  Poplar leaves are generally palatable to stock, but they will be less so when shed than when removed fresh from the tree. My observations suggest that leaves that fall prematurely in drought conditions are fresher than the normal autumn-fallen leaves and will be more readily ingested by hungry stock. The rapid removal of leaf fall in the autumn by grazing, would also limit the shading effect of leaf litter on pasture growth in autumn. The utilisation of autumn leaves by stock appears to be poorly understood and requires further research.

Observations in the Hawke's Bay Regional Council nursery indicated that sheep, which are used in late summer to tidy up, have variety preferences for leaf litter. Incidentally, these were not linked to the palatability of poplar clones to possums. The poplar scientists probably think that they have enough factors to breed for, but this could well be a characteristic warranting some attention.

3. Animal welfare

Shade. In the last drought, on a moderately hot cloudless day (1/3/98) – the 1 pm temperature was 30°C at my shaded back door. I placed my thermometer on the ground under my poplar trees (of course they could have been any species) where it recorded 26°C. I then placed it 50 meters away on open ground and it rose to 39°C. This was the simplest of experiments, but it shows that the impact of shade on livestock comfort must be considerable. Certainly, the stock themselves testify to its importance merely by seeking shade. Guevara-Escobar (1999) found that the soil temperature under poplars was 2–3°C cooler than for adjacent open pasture throughout the year.

Shelter. As poplar is a deciduous tree, winter shelter from cold weather through foliage does not exist, and this includes the vulnerable lambing/calving period. However, some wind force breakdown through a canopy of branches is likely to occur. Besides, there can be strategically placed evergreen trees in the plantation pattern. More research, which would be relatively simple to carry out with modern wind-recording apparatus, is needed here.

Animal behaviour. Data on this are difficult to obtain, but indications are that the aggressive behaviour patterns of bulls may be reduced under a semi-forested situation, possibly through the breaking up of the vista by the trees (Chamove & Grimmer 1993).

Public perception. Much of the livestock throughout the drier areas of New Zealand, nowhere more so than Hawke's Bay, have no or limited access to shade, and this is providing a very poor public image for our industry. Likewise, any reduction in the vulnerability of livestock to harsh cold weather will enhance the industry's image (Matthews 1996). While it is difficult to demonstrate the benefits of shade and shelter with respect to animal production (Gregory 1995), we must

expect that the representation of excessively exposed stock to extremes of heat and cold will eventually have a market impact.

As indicated, the focus of this paper is to emphasise the possible contribution to the interests of the livestock producer of poplar silvopastoralism. However, it is appropriate to touch on several other benefits of poplars, which while not specifically of interest to the livestock operation, stand to substantially benefit the landowner. That they are not dealt with in detail here, should not be seen as diminishing their importance.

4. Amenity, general landscape value, and rural community

Forestry establishment of any kind profoundly alters the landscape and poplar silvopastoralism certainly can do so in a relatively short time. I know as my vista – north, south, east and west – has been dramatically changed in just one generation from a treeless landscape to a forested one with dramatic colour changes. The deciduous characteristic of the poplar allows a range of translucent hues for a short period during leaf burst in the spring and with the modern varieties, change to a butter yellow in the autumn.

Real estate agents I talk to testify to the effect on rural land values of an impressive landscape. Trees, even if only planted for economic reasons, will add to capital values. If there is no intention to realise on that asset then the improvement to the quality of life of the farm owner, the family and workers, while intangible, is still real.

In this context it should be noted strongly that the core land use – livestock, and with it family ownership – has not changed and so the rural social pattern is not affected. This is certainly not the case with blanket *Pinus radiata* forestry.

5. Carbon storage

The reduction of global warming through mandatory reductions in greenhouse gas emissions will be a major global issue in the next century. The Kyoto Protocol, to which New Zealand is a signatory, is planned to become effective in about a decade. This is likely to involve the penalising of ruminating animals and the crediting of forestry. Guevara-Escobar (1999) found that a poplar-pasture system contained 27% more carbon than the adjacent open pasture. The ability of farmers to minimise net carbon emissions from their enterprises is therefore a potentially important medium-term benefit of tree planting.

6. Timber production

Poplar, and increasingly plantation-grown poplar, is a major timber in many countries and has broad market acceptance. Its characteristics lend it to a wide range of utility usages, particularly in processed forms, for example food packaging as it is white, odourless and tasteless. Another challenge for New Zealand over the next decade is to explore commercial opportunities for this timber and to develop a larger and higher quality resource to capitalise on those opportunities.

Conclusions

We believe that silvopastoral practice using poplars offers the next generation of hill country farmers considerable opportunity and challenge with impressive potential environmental and economical benefits. Silvopastoralism using poplars is not an academic concept but is a reality, evidenced by the many mature poplar plantings on New Zealand farms. What is lacking is an appreciation by the livestock industry of the opportunity that exists with silvopastoralism using poplars. A scientific evaluation of the concept of integrated productive landuse is also lacking. The presenters of this paper and others are working to rectify this deficiency and challenge the livestock industry to also enter the debate.

Points warranting further consideration are:

- The need to collate and extend the considerable practical knowledge that has been built up in recent decades. The development of the Soil Conservation Planner by Landcare Research, AgResearch and Hort+Research will go some way toward achieving this.
- That the momentum of research work now being undertaken be further supported and developed.
- The poplar selection programme be scaled up, not down, and for it to give greater weight to form, leaf palatability (to stock) and timber value.
- Timber opportunities be developed.

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