Hop Growing in England in the Twenty First Century

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Abstract

Peter Darby describes how new methods of hop production, particularly the development of dwarf varieties, can address the needs of the English hop industry to reduce labour requirements, reduce environmental impact and retain a competitive position in world trade.

Introduction

Hop growing has been a feature of the English countryside since the 1520s reaching a peak in the nineteenth century with 29,053 ha in production (Burgess 1964). For many reasons, during the twentieth century the area diminished until, in 1999, it stood at 2,631 ha. The area required declined as better control of pests and diseases ensured a consistency of supply, and new varieties, particularly those resistant to wilt disease, provided greater productivity of brewing constituents. Brewery use of hops became more efficient, especially as processed hop products were developed, and tastes changed towards less bitter beers which used less hops. Deregulation of the English hop industry with the abolition of the Hops Marketing Board in 1984 opened the domestic industry to fierce international competition. A series of good harvests in the late 1990s across the World produced a surplus of hop bitter acids in brewery and merchant inventories which has severely depressed prices.

The English hop industry now faces a number of challenges. This paper outlines these challenges and describes how they are being addressed by hop research funded by hop growers through the National Hop Association of England and the government through Defra. This research aims to ensure that hop growing remains a feature of the twenty first century English countryside.

Labour and mechanisation

The rural population in Britain is rapidly diminishing as society becomes more urbanised. This impacts greatly on the availability of suitable labour and will be a major factor in the shape of English hop growing in the twenty first century.

A feature of English hop growing has always been the need for a considerable supply of labour, particularly in the spring for hop training and in September for hop harvest. England differs from the rest of Europe in this respect because the average hop farm enterprise, at about 15 ha, is too large for the grower to use only family labour. Hop training involves manual removal of excess hop shoots and putting chosen, uniform shoots on to the strings. This operation has traditionally involved local rural labour. Harvest operations, in contrast, have usually recruited a large itinerant workforce. Paradoxically, the availability of labour in large adjacent urban conurbations was the main factor concentrating hop growing in England into Kent and Sussex, and Hereford and Worcester. However, changes in social expectations among these urban populations mean that they are no longer a source of labour. The introduction of hop picking machinery during the 1950s and 1960s to replace hand-picking reduced the labour requirements by almost 90% but it still requires about 12 people to service a hop picking machine.

Larger farms may have three or more such machines to ensure that all the crop can be harvested in optimum condition within a relatively short time. There remains a high labour requirement which is increasingly difficult to find, and is likely to become even more problematic with recent changes in eastern European countries. The cost of labour, which can

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be 20 –30% of growing costs, is also a constraint on the competitiveness of the English hop industry against the economies of scale experienced in the USA and the use of family labour in the rest of Europe.

Whilst casual labour is increasingly costly and scarce, the specialised hop growing skills provided by permanent farm staff are also becoming rarer and seen as less attractive to younger farm staff. These skills are being lost to the industry.

Hop research has addressed these problems through the development of a simplified growing system which allows much greater mechanisation and reduction of labour requirements. Known as "low-trellis" or "dwarf" or "hedgerow" hop growing, this involves growing hops to only 2.5-3m high rather than 5-6m high as in conventional husbandry. Conventional wirework involves the construction of a costly permanent rectangular lattice of wires suspended from poles and anchored at the four corners of the field. In the new system, the hops are grown as a continuous hedge on strings or netting supported by a tensioned top wire suspended on poles. Each row of hops is independent, and separately anchored. The technology has been developed as an extension of fencing technology and requires no specialised skills to erect. Similarly, methods for the erection of horticultural netting on this wirework structure have been refined so that the specialised skill of annual hop stringing is no longer needed. In effect, the hop field becomes a series of short fences about 2.5m apart.

Although some growers using this new system still prefer to gain maximum yield by careful attention to training husbandry, many growers have abandoned training labour completely and allow the hops to scramble on to the netting and self-train, making a few adjustments to the growth later in the season to even the distribution of bines.

The major advantage of this dwarf system is at harvest when a mobile harvester can be used to remove the cones directly in the field. In conventional hop growing, the bines are cut down, loaded on to a trailer and removed to a static picking machine. The first mobile hop picking machines were developed in the USA during the 1940s to address the same problem of a shortage of labour during the war years. However, they were not successful because the mechanism could not cope efficiently with the volume of hop material arising from full height bines. In England during the 1970s, similar modified combines were developed to harvest full height bines in the field but these too were unsuccessful because of the weight of the machines working in wet soils during an English September. With the development of dwarf growing systems, concepts for mechanical harvesting being used for grapes and bush fruit were adapted for harvesting of hops ensuring that the machine remained as light in weight as possible. The resulting prototype machinery developed by researchers has been used by manufacturers to produce commercial dwarf hop harvesters and these have been in use in England since the mid-1990s. The harvester combs the hop cones and lateral leaves from the hedge and these are taken by a trailer to a static cleaning machine. The volume of leaf is so small that the cleaning capacity on a standard hop picking machine can cope without attention and little or no labour is required at the cleaner. With this system, to service the same area of hops as a conventional hop picking machine, takes only four people, representing a considerable saving in labour. On many farms which have adopted this system this amount of labour can be provided by family members or permanent farm staff without the need to recruit casual labour.

Although individual growers apportion their farm accounts in different ways, growers have been using this new system for nearly 10 years and there is general agreement that the recurrent costs of production are reduced by approx. 45%. There are also considerable savings in capital costs of establishment of low-trellis systems. Including the costs of plants and the harvester, such costs are at most 75% of a conventional field and markedly less after initial investment in the system.

Trials and semi-commercial production of existing conventional hop varieties on a low-trellis system have indicated that only a few varieties are suitable and that the maximum yield is only 63% of normal conventional production (Darby 1999, Lewis 1990). Thus, the cost savings in the production system are almost lost against the reduction in yield. What is required are new dwarf varieties bred especially for growth on the hedgerow system.

The development of dwarf hop varieties

The dwarf breeding programme at Wye started following the discovery of a compact "dwarf" plant in 1977. It would seem that such plants had been present amongst the breeding lines at Wye throughout the twentieth century but their potential value had been unrecognised. In 1911, for example, breeding records note an unusual seedling of 'Fuggle' which had "laterals of medium length, very closely placed". This and other descriptions indicate that this plant was a dwarf plant. It was noted as "very fruitful" but "of no *direct* promise", perhaps suggesting that it looked interesting but not for the production methods of that time. Dwarf plants have now been identified at a low frequency in several other breeding programmes throughout the World.

The 1977 discovery was of a female seedling[2] but analysis of its cones indicated that it had only 1% alpha-acid content[3] and, therefore, considerable breeding effort would be required to incorporate the dwarf characteristic into a variety with commercial value. However, useful information was obtained on the heritability of the trait and the yield potential of such dwarf plants (Darby and Farris 1991, Darby 1994). Progress accelerated with the discovery of a second dwarf plant in an unrelated breeding line. This was a male plant from the main high alpha-acid breeding programme and, within two breeding cycles, dwarfs were being obtained with alpha-acid contents above 10%. Detailed analysis of the inheritance patterns indicated that the characteristic was a combination of several different traits inherited separately to varying extents, including such traits as a low stature, a short internode length, and a low flowering node. From this information, the blueprint for a commercial dwarf variety was defined and a programme to breed and select a dwarf hop variety was initiated in 1985. By 1992 three selections had been identified for establishment on farm trials. With the active and enthusiastic co-operation of hop growers and brewers, the farm trial stage established the yield potential of these new dwarfs to be at least 80% of conventional yield, and confirmed the economies to be made from the new system. The selections were registered as 'First Gold', 'Herald' and 'Pioneer', the world's first dwarf varieties, in 1996.

Breeding continues at Wye to improve the performance of dwarf varieties and to give the grower and brewer a portfolio of dwarf varieties. The growers need a range of different maturities to widen the harvest period, and brewers need a range of hop flavours for different brands. Further dwarf varieties have been registered including 'Pilot', where the yield is equivalent to a conventional variety, and recently 'Boadicea' which is discussed later. In addition, dwarf varieties 'Prima Donna' and 'Diva' have been produced as decorative climbers for the domestic gardener or dedicated home brewer.

Environmental considerations

The effect on the environment is an increasingly important feature of the cultivation of all crops. The public need to be assured that crops are grown with minimal impact on the rural environment, using safe procedures for the farm operatives, and producing food which is free of pesticide residues. This is a particular challenge for hop growing where vulnerability to pests and diseases has meant that routine high-volume spraying of pesticides has been the normal practice throughout most of the twentieth century.

The cool and damp maritime English climate, particularly in September as the hop crop matures, favours attack by pests and diseases and a field of hops presents an easy target for several reasons. Hops are a perennial clonal crop propagated by cuttings originating from a single individual seedling plant. It is, therefore, genetically uniform, with a very large area of

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[2] Hops are a dioecious species in which only the female plants are cultivated, the males having little brewing value.

[3] Hop resins comprise the alpha-acids, beta-acids and uncharacterised resins. The alpha-acids, when isomerised by boiling during brewing, impart bitterness to beer. The amount of bitterness is directly proportional to the alpha-acid content.

leaf or volume of root, and growing at the same location for many years continuously. As a consequence, attacks by pests or diseases can, if left unchecked, result in total crop failure. Records indicate that during the nineteenth century, a hop grower might expect a full crop only once in every 10 – 20 years and it was to allow for these losses from pest and disease that the cultivation of hops was so extensive, particularly in Kent and Sussex. However, with the advent of effective synthetic pesticides and fungicides starting in the early 1920s, English hop production stabilised and the area required for production contracted (Neve 1991). Pests and diseases not only affect productivity, but also quality. Even very low levels of damage to hop cones can affect the brewing quality and render the hops unsaleable. Sales of hops are based on a visual and organoleptic evaluation of samples of the crop gathered at regular intervals. Thus, the hop grower strives to be totally free of pests and diseases throughout the growing season so that no damage can be detected on the harvested cones. This is achieved by the application of pesticides as an insurance measure every 10 – 14 days throughout the entire growing season. The volume of application increases from about 300 l/ha on small plants at the beginning of the season to in excess of 2000 l/ha to the full crop. These high volumes are applied through air-assisted sprayers producing a large cloud of droplets. Furthermore, the young susceptible cones are produced at the top of the wirework, some 5-6m above the ground and therefore, to ensure adequate coverage, the spray cloud is projected well above the crop to allow it to settle back down on to the cones. These procedures can easily result in extensive spray drift impacting on the environment.

A major driving force towards dwarf hop production is the need to reduce this potential for environmental impact from the use of pesticides. Notwithstanding any inherent resistance to pests and diseases incorporated into new dwarf varieties being developed, the system has considerable potential to reduce dramatically the amount of pesticides being used and their impact on the wider environment.

The lower height of a dwarf hedge makes the foliage a more accessible target for sprays which can be applied using hydraulic pressure alone. This, combined with improvements in spray technology such as the development of bubble-jet nozzles, can reduce the quantity and volume of spray application. Growers of ‘First Gold’ have reported a greater than 50% reduction in the quantity of pesticides used compared to a conventional hop crop (Davies 1994). The lower spray volume in itself will reduce potential drift but this can be enhanced through the use of ‘tunnel’ sprayers where the spray is applied within an enclosed space surrounding the spray target. The air speed and direction are more constant and drift is restricted by the enclosure. Some such machines also have the capability to collect and recirculate any excess spray making very efficient use of low volumes of pesticides. The use of such developments from orchard spray technology is only possible in hops because of the absence of cross-bracing wires between the rows and the lower height in dwarf production. The hop industry should be well placed to embrace future changes in legislation regarding spray application.

The lower height also makes crop inspection easier. It is possible to monitor the entire length of a dwarf hedge whereas only periodic samples can be assessed 5m above ground in a conventional hop crop. The close monitoring of the crop for pests and diseases allows sprays to be applied more according to need and less as a routine insurance. It also enables the effectiveness of the pesticides to be monitored so that remedial action can be taken as required.

When hops are grown as a hedgerow there is continuous contact between plants during almost the entire growing season. In contrast, hop plants grown conventionally are distinct from each other and leaf contact only occurs at the very top of the plants at the end of the season. The continuous contact in the dwarf system is particularly beneficial for the action of predatory species where mobility is a key factor in their effectiveness in pest control. It is an often quoted anecdote that wild hops in a field hedge boundary will be clean of pests but the cultivated hops growing in that field may be badly affected by pests. This is usually explained by the action of a diverse range of predatory species found in the hedge but absent from the conventional hop plantation. Apart from the effects of incompatible spray applications, the beneficial insects are discouraged by the physical separation of the plants and the hotter and drier conditions found towards the top of a conventional hop plant. Some interactions will occur lower on the plant but damage will occur where the pests are not predated at the top of the plant. The lower height and greater foliar density in a dwarf hop hedge produces a cooler and more humid microclimate which is more conducive to the activity of beneficial insects. Observations indicate that arthropod species biodiversity is increased in dwarf hop production. Dwarf hops offer the potential to reduce pesticide usage by effective deployment of predatory species, either occurring naturally or introduced. Thus, integrated hop production, where pesticide use is compatible with beneficial species, will be a feature of hop growing in this new century.

In a conventional hop field, the plants are removed from the field at harvest. In contrast, the hop bines are not cut with the dwarf system but are allowed to senesce as winter approaches. This provides a new arena for pest and predator interactions on the leaves that remain in the field for several weeks after harvest. Over-wintering populations of pests are reduced and beneficial species are encouraged to remain in the hop field, further enhancing the potential for consistent biological pest control in the new production system.

The diminishing arsenal of pesticides available to minor crops is a major problem for English hop growers. The key to dramatic reductions in pesticide use on hops has been predicted to be the combination of host plant resistance to the damson-hop aphid with the dwarf habit and hedgerow growing system (Darby and Campbell 1996). This has recently been achieved with the development of dwarf variety 'Boadicea', the first hop variety in the world to incorporate strong natural resistance to the hop aphid. During its farm trial stage, it was grown at one site with no applications of pesticides at all. Such new dwarf varieties indicate that English hop production in the twenty first century will be possible with much lower pesticide inputs.

A competitive industry

Investment in research by English hop growers has given them an opportunity to reduce significantly their labour requirements and reduce their pesticide applications. Both of these aspects reduce their costs of production and enable the English grower to be more competitive in international trade. The price of hops on the world market is determined largely by the supply from the largest producers, Germany and the USA, and the demand from the major world brewers, mostly outside the UK. Thus, the English producer has to work within a price structure unrelated to UK production and economies in production costs are, therefore, clearly advantageous.

Competitiveness also arises from the ability to react quickly to changes, and growers have noted that the new dwarf system greatly increases their ability to do this. With no permanent wirework, it is possible to use fresh land and to erect the relatively inexpensive new wirework quickly and easily. Because each row is independent, only as many rows need be constructed as are needed to meet contract quantities. Acreage can be adjusted to accommodate changes in contract or demand. Furthermore, a single field can be used for hops and other crops. With little need for casual labour, management of harvest operations is simplified and the integration of hop operations with production of other crops is easier. For some growers the flexibility of the whole system is one of its most important attributes.

Conclusion

Although it is a very traditional crop, English hop growers have always shown a willingness to embrace new technologies and methods of production. The adoption of new dwarf varieties gives English hop growers in the twenty first century the opportunity for a competitive, sustainable, modern industry meeting the demands and expectations of brewers and the general public.

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Journal of the Royal Agricultural Society of England
Volume 165 2004
ISSN - 0080 - 4134

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