

Growing wheat for alcohol/ biofuel production



Producing alcohol from wheat

Wheat is likely to become a major biofuel crop in the UK. Production processes differ between potable and fuel alcohols, but similar principles apply. Usually, cereal grains, such as wheat, are milled and water is added; cooking gelatinises the starch. Enzymes are added to convert the starch to sugar, which is fermented by yeasts. Ethanol is distilled from the fermented mixture.

By-products are dried distillers' grains with solubles (DDGS) and carbon dioxide in roughly equal amounts by weight.

- Processors require grain giving high alcohol yields and high processing efficiency. Several characteristics affect these parameters, eg starch content, moisture content and viscosity.
- Low mycotoxin levels are also required because DDGS are usually fed to farm animals.
- Feedstocks for biofuels may have to be produced under an accreditation scheme for associated greenhouse gas (GHG) emissions – see the HGCA **Bioethanol greenhouse gas calculator** (www.hgca.com).

Grain quality for alcohol production is best measured directly in the laboratory. To date, about 400 wheat samples have been analysed by the Scotch Whisky Research Institute (SWRI) using a method mimicking production of potable alcohols. Biofuel processing would be expected to give similar results.

Key messages

If growing wheat for an alcohol market, determine grain specification and crop accreditation requirements.

Research to date suggests that the best strategy will be to:

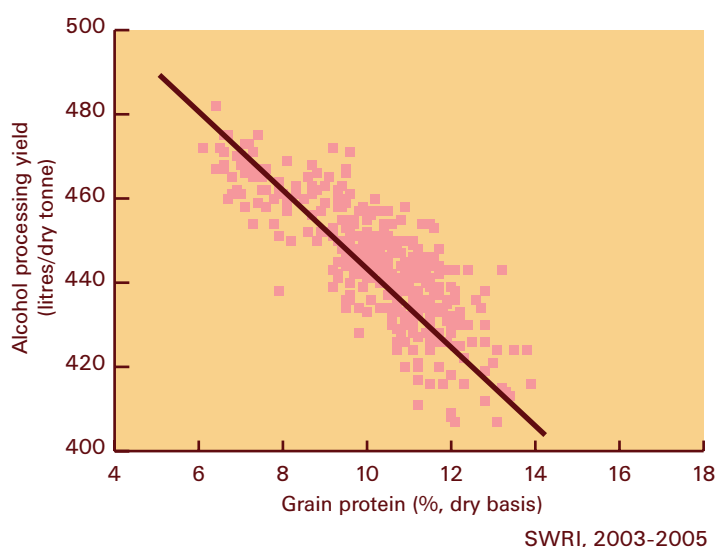
1. Grow a soft-milling, high yielding variety (see **HGCA RL**).
2. Select a high yielding situation.
3. Avoid over-application of fertiliser N.
4. Avoid late application of fertiliser N.
5. Manage grain production and drying to avoid mycotoxin development.

Always consider your local conditions and consult a professional agronomist if necessary.

Assessing grain quality

Alcohol processing yields and grain protein were measured on 20 HGCA-funded variety trials from 2003 to 2005. Alcohol yields were related inversely to grain protein content, increasing by about 7 litres/dry tonne for every 1% decrease in grain protein (Figure 1). This is consistent with direct replacement of protein by starch.

Figure 1. Low protein wheats have the highest alcohol processing yields



In the future processors may offer premiums for low protein or high starch. They may analyse grain at point of trade using near infra-red reflectance (NIR). Ongoing work is seeking NIR calibrations for alcohol processing yield.

Choosing varieties

Figure 2 combines SWRI results for alcohol processing yield (blue bars) with mean grain yields from **HGCA Recommended List** trials, so that predicted alcohol production (green bars) can be compared.

The variety Glasgow is predicted to produce the most alcohol (litres/ha), 10% more than Riband. Predicted differences between current HGCA Recommended varieties are mostly due to differences in grain yield, rather than processing yield.

The best varieties to grow are likely to be those soft wheats which combine high yields with good disease resistance and agronomic features. Older soft varieties, eg Claire, Consort and Riband, gave reasonable alcohol processing yields but predicted alcohol production is low, due to their low grain yields.

The HGCA Recommended

List indicates varieties suitable for distilling. Distillers of potable alcohol currently dislike hard varieties and varieties with the 1B1R (rye) translocation, eg Ambrosia, but new biofuel processing plants might accept these. No processing data are currently available on the performance of hard varieties, eg Solstice, Einstein and Gladiator.

Until further data are available, conclusions from Figure 2 should be considered as tentative. This applies especially to Alchemy and Hyperion (varieties in brackets in Figure 2) for which data are only available from 2005.

Managing wheat for alcohol production

In general, crops grown for alcohol production should be managed as for feed wheat to maximise yield. This maximises GHG benefits as well as profitability. Starch formation is best in northern UK, but grain will be needed for alcohol production throughout the UK. The best growing conditions are those where high yields are expected, eg following a break crop on moisture retentive soils. Avoid fields prone to drought or at high risk of take-all.

Typical N response curves for alcohol are shown in Figure 3. Further research is needed, but it is likely that there will be benefits from reducing N applications and from making them earlier than is normal for feed wheat production. Adjustments will be affected by any premiums offered for grain quality and, eventually, for GHG savings.

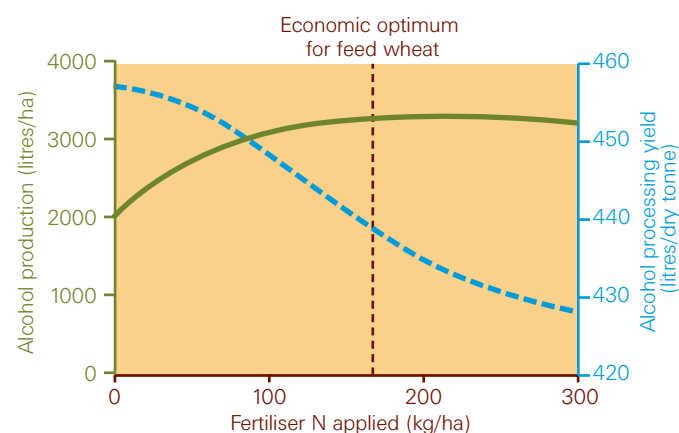


Figure 3.
N response of alcohol production (green line) and processing yield (dotted blue line), inferred from protein via the relationship in Figure 1

Background

With a UK government target of 5% of transport fuels from renewable sources by 2010, a significant market for biofuels is emerging. Wheat will be the principal feedstock for bioethanol, and in the future, possibly biobutanol. Some 3m tonnes will enable production of sufficient ethanol to replace 5% of current petrol usage, in addition to the 0.7 million tonnes currently used for potable alcohols.

Varieties in HGCA-funded Recommended List trials and other projects have been tested for alcohol yield over recent years by SWRI. A full report of this work is available as HGCA Research Review No. 61.

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Research Reviews 29 and 61

HGCA Recommended List for cereals

Bioethanol greenhouse gas calculator (see www.hgca.com)

Ongoing projects 2979, 3186, 3314, 3335 and 3357

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