NSW GOVERNMENT Industry & Investment

FACTSHEET

Organic spelt production

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Spelt (*Triticum aestivum* var. *spelta*), is one of the oldest cultivated grains, preceded only by Emmer *(T. dicoccum)* and Einkorn *(T. monococcum)*. These grains are collectively commonly known as the 'Hulled' wheats. Their kernels are covered by tough palea and spikelet glumes. Cultivated wheats – durum-type and bread wheats – are free-threshing crops.

The presence of the tightly bound glumes on hulled wheats has major implications for crop agronomy and processing. The exceptionally thick spelt husk makes it more difficult to process than modern wheat, as it needs to be de-hulled and broken from its husk before processing. However, the tough hulls give the grains protection in the field and in storage; helps to retain nutrients and maintain freshness over a longer period than other grains; and may help the grain to tolerate wet soil conditions by protecting it from some fungal diseases.

Agronomically, spelt is tall with moderately weak straw and is later maturing than most common wheat varieties. Spelt needs to be planted about the same time as winter wheat and can be grown in most areas where winter wheat is planted. Spelt is adapted to lower fertility soils than wheat giving it greater suitability for organic farming rotations.

Production and demand

In the early 1900s there was up to 200,000 hectares of spelt grown in the USA. Data on spelt production in the USA shows farmers are growing both certified organic and conventional spelt. Certified organic production statistics show that organic spelt acreage planted has fluctuated significantly over the last couple of decades. According to the USDA USA farmers planted 5,000 hectares of certified organic spelt in 1995, with that number dropping to 3,300 hectares by 2005 and varying in between.

Spelt's popularity has seen a more recent resurgence largely due to its health benefits and its distinctive taste attributes. Some say it's milder and sweeter than wheat, others say it tastes nutty. A 2004 publication of the Washington State University Extension notes: "Today there is new interest in spelt among people who are looking for alternative foods, heirloom varieties, or certified organic grain products."

Spelt was first commercially grown in Australia by Geoff and Julie Brown of Buckwheat Enterprises, Parkes NSW, in 1989. Buckwheat Enterprises continues to produce high quality spelt products for both domestic and export markets.

Production in Australia is currently estimated at 4,000 tonnes, with an estimated retail value of processed organic spelt products of $7.7 million. Estimates suggest that markets currently exist for approximately 10,000 tonnes of organic spelt grain per annum with an on-farm value of $10 million (de-hulled), and retail value of $19.2 million. While the greatest demand is for organically produced specialty grains, poor yields and market irregularities are frustrating industry expansion.

Figure 1: Spelt genotype evaluation trials at Industry and Investment NSW Organic Research Site at Yanco. Photo: R. Neeson.

Environmental adaptability of spelt

Under optimal growing conditions the yields of organically grown spelt are lower than organically grown wheat. Spelt averages around 2–3 tonnes/ha, whilst yields of 4–5 tonnes/ha are possible for wheat. Organic farmers will often graze spelt during the growing season, however

the impact of this practice on spelt yield is unknown.

Under sub-optimal growing conditions some research suggests that spelt out-performs many traditional grains (such as wheat) and is able to better utilise nutrients when grown in a low-input system, suggesting spelt could play a greater role in Australian organic cereal rotations.

Trials conducted in 1997 by 22 research institutes in nine countries by the European Union's EU-Agrinet's SESA project (Spelt for European Sustainable Agriculture), showed that "spelt was surprisingly adaptable; particularly in poor soils and very wet weather conditions. It could tolerate being sown later than wheat in mid- mountain areas and could withstand being waterlogged better than wheat. Spelt also has a lower requirement for soil nitrogen than wheat grown in the same conditions".

There is no evidence to suggest that spelt is better able to adapt to drought conditions than common wheat. Under limited water it was found that spelt had a higher mortality in tillers compared to common wheat cultivars. Some researchers have suggested that the hardiness often attributed to spelt is more likely to be a factor of its tolerance to low temperatures and/or excess moisture, for example in heavy waterlogged soils, rather than a tolerance to drought.

Aluminium (Al) toxicity is one of the major constraints limiting plant growth and crop productivity in acidic soils. Evaluations of 125 spelt accessions at Wagga in 2008 revealed that 37 accessions were tolerant to Al (Raman, 2008).

Watanabe et al. (1992) compared the salt tolerance of several wheat cultivars and related species and concluded that the speltiform wheats (*T. aestivum* group *spelta* and group *vavilovii*) were less salt tolerant than other wheats based on changes in water-vapour diffusion resistance and specific leaf area.

Due to its extensive root system there are some suggestions that spelt may be useful in erosion control.

Uses for spelt

The most common use for spelt is as a substitute for wheat flour in breads, pasta, cookies, crackers, breakfast cereal, cakes, muffins, mixes for breads, pancakes and waffles, and in animal feedstuffs. Spelt has high protein content and makes high-quality bread. It can also be used for making beer and for spelt rice (partly de-hulled, polished whole grains). Europeans use spelt in the production of beer, gin and vodka.

Research in Europe and North America showed that whilst spelt has higher protein content than common wheat, with reported averages of 12.1 – 17.1%, it also has inconsistent yields, low test weights, a limited range of adapted cultivars, and requires an expensive de-hulling process.

People suffering from certain allergies to wheat have reported that they are able to tolerate products made from spelt. The gliadin and glutenin composition of spelt is very similar to wheat. Therefore, people with wheat allergies who are able to tolerate spelt are suffering from something other than gluten intolerance. Since spelt and wheat are so closely related, both genetically and bio-chemically, it is difficult to determine what factors may be responsible for the reported non-allergenic properties of spelt. The Gluten Intolerance Group of North America states that barley, durum and semolina wheat, common wheat, farina, Kamut®, rye, spelt and triticale contain gluten and *should not* be consumed by coeliacs.

Spelt for livestock feed

The use of spelt and its by-products for livestock feed may hold the greatest promise for future use. In animal feed the hull fibre is particularly beneficial for ruminants, such as cattle, as it increases the digestibility of the feed and reduces acidosis problems. Its low amylase and fibrous hull reduce the speed of sugar production, while high protein is attractive in relation to lower energy levels. Spelt could therefore also be considered as an additive in finishing-off feed rations. Mouth irritation in livestock can be a problem; this can be reduced if spelt is ground before feeding.

European and some North American farmers have traditionally used spelt as a feed-grain substitute for oats because cold, wet springs often hindered spring oat planting. The feed value of hulled spelt is similar to that of oats. When harvested for forage, yields and protein content of winter spelt were significantly higher than for spring oats. No significant differences in growth were noted when maize was replaced with spelt in chicken and poultry rations, but feed conversion was adversely affected. When fed to dairy cows, milk production was highest from maize-fed cows, whilst weight gain was highest from spelt-fed cows. Higher efficiency values were obtained from oats and spelt than from maize (Ingalls et al. 1963).

Organic farmers often graze spelt crops, however the impact of this practice on livestock production and on spelt grain yield potential is unknown.

It is claimed that spelt straw produces excellent bedding material for livestock.

Cultivar selection

In Australia, a number of spelt cultivars are held in the Australian Winter Cereals Collection at Tamworth, NSW. Commercially, spelt cultivars have been sourced both from the Winter Cereals Collection and from unknown sources where anecdotal evidence suggests that whole grain spelt was imported for the health food market and subsequently seed increased for commercial cultivation. A spelt which is grown under commercial organic production in the NSW Riverina, and locally referred to as 'Kamarah', is a mixture of two cultivars, both of which are thought to have originated in Spain.

Industry & Investment NSW assessed over 100 spelt cultivars and found two which exhibited superior yield and quality characteristics when compared to those currently being commercially grown.

Figure 2: Spelt genotype ST1040

Figure 3: Spelt genotype ST1041

These cultivars ST1040 and ST1041 (*pictured*) were found to have superior yield, quality and disease resistance characteristics. The average yields for the new cultivars (2.73 t/ha) are on average 0.67 t/ha above those of 'Kamarah', but below wheat (3.77 t/ha) and barley (4.42 t/ha) when grown under organic production techniques. The selected spelt cultivars reached anthesis an average of 15 days before 'Kamarah'.

The newly selected cultivars produced more tillers and more biomass and, combined with their acceptable yield, may be suitable for a graze and grain production system. It should be noted however that the impact of grazing on the cultivars' yield or on livestock productivity has not been evaluated.

Screening of spelt cultivars for disease susceptibility indicated that the three selected cultivars showed Moderately Resistant (MR) to Resistant (R) levels of susceptibility to both stripe and stem rust.

The hull of commonly grown spelt is notoriously difficult to remove necessitating special processing facilities. Difficulties in sowing hulled grain may also be experienced. ST1040 is semi free-threshing and ST1041 is tightly hulled.

Some farmers and processors have indicated a preference for hulled spelt, citing improved disease resistance and storing ability, so producers and processors will need to weigh up the benefits of the naked cultivar over hulled cultivars when selecting a suitable cultivar.

Undesirable characteristics of the new cultivars include a susceptibility to lodging, particularly in more fertile soils. ST1041 is prone to shattering (brittle rachis) if not harvested at the correct time and can result in significant yield losses. Early maturing (flowering) cultivars can be more prone to frost injury. None of the new cultivars are suitable for sowing in acidic soils as laboratory tests have shown them to be intolerant of aluminium.

Crop establishment

Weed management

Spelt is slow to establish and can be easily choked out by rapidly growing weeds. With organic management careful planning is required with the aim to sow into a weed-free seedbed.

Organic weed management can be achieved by implementing a combination of the following strategies:

Long term strategies:

- Monitor paddocks and identify weed problems. Understand the growth habit, lifecycle and seeding characteristics of the weed species to strategically manage weeds at their most vulnerable growth stage and to prevent seed set;
- Regular soil monitoring and improving soil fertility and soil structure to encourage vigorous crop growth and to discourage weeds;
- Developing a good rotation design where previous cropping utilises practices which prevent weeds from occurring or setting seed. Vigorous pastures or green manure crops can out-compete weeds. For example, growing a high density cover crop prior to mulching the

crop and then drilling the spelt seed into the retained stubble.

- regular slashing, mulching, cutting silage/baling and grazing management to prevent weed seed set;
- Preventing the importation of weed seeds onto the farm by implementing good farm bio-security (hygiene) practices such as thorough cleaning of sowing and harvesting equipment and ensuring that planting seed is well graded and free of weed seeds.

Short term strategies:

- Sowing whilst soil temperatures are still warm is the preferred option thus avoiding potential problems of slow establishment and excessive weed growth in winter;
- Shallow cultivation to stimulate weed emergence (e.g. annual ryegrass), or cultivation following emergence of winter weeds prior to sowing;
- Intensive grazing of weeds with livestock prior to sowing;
- Use of flame or steam weeders prior to crop emergence to destroy young weeds;
- Post-emergence harrowing of emerged weeds following spelt establishment (2-3 leaf stage);
- Increase sowing rate to 'shade out' weeds

Other techniques such as pasture cropping could be considered thus avoiding excessive cultivation; however the impact on spelt yield is unknown.

Crop nutrition

Nitrogen

Overseas research has shown that spelt has a lower nitrogen requirement than wheat (about 25-30% less) giving it greater adaptability for organic farming rotations. It has been suggested that where more than 20 mg/kg[1] soil nitrate N is present, nitrogenous fertilisers are not required. Depending on levels of residual soil N levels, sowing spelt directly following a leguminous cover crop / green manure may result in the spelt lodging,

Phosphorus and potassium

For optimum yield the phosphorus and potassium requirements of spelt are similar to wheat or barley. However, trials conducted by Industry and Investment NSW showed that in soils low in phosphorus spelt had a greater tillering capacity (and higher biomass) when compared to wheat but this did not translate into higher yield. This could

Figure 4: Industry standard spelt "Kamarah".

be advantageous when selecting a rotation in low phosphorus soils and/or where a higher biomass is desirable such as a graze and grain option.

Sowing

For optimal establishment growers should aim for a paddock that is free of weeds. Most organic producers sow into well cultivated seed beds however direct drilling into stubble mulch or pasture should be considered as more sustainable options.

Time of sowing

Trials conducted by Industry and Investment NSW found that spelt cultivars differ widely in their photoperiod and vernalisation requirements. Research showed that early maturing spelt cultivars out-yield later maturing cultivars and that sowing whilst soils and temperatures are still warm, is the preferred option. Trials found that the optimum sowing date for the spelt cultivars ST1040 and ST1041 was from early May – mid June, however earlier sowing may also be successful.

It seems however that spelt is fairly adaptable - spelt is sown in Europe as a winter crop, in the USA and Canada as a summer crop, whilst in temperate areas it can be sown later in the season than common wheat.

Sowing and sowing depth

Optimal sowing depth for spelt is the same as wheat, i.e. around 4 cm or 6 cm in sandier soils.

Hulled wheats are often stored as spikelets because the toughened glumes give good protection against pests of stored grain. Hulled varieties of spelt are traditionally sown with the hull on. Attempts to remove the hull can lead to a large proportion of damaged, and as a consequence, unviable seed. It is also believed that the hull may protect the grain against pests and diseases in the field prior to germination.

The presence of the hull, however, can lead to sowing difficulties with blockages in drop tubes the most common. Replacing ridged drop tubes with smooth tubes will help to alleviate this problem, however reducing sowing speed and regular checks for blockages during sowing is essential. The availability of free-threshing cultivars would facilitate sowing operations.

The presence of the hull slows germination and therefore emergence. Slower germination may be problematic if soil moisture is limiting, but may also protect the seed if sown dry.

Figure 5: Many farmers prefer to retain the hull on spelt during storage to protect grain against storage pests.

Seeding rate and row spacing

Industry & Investment NSW conducted trials with spelt utilising 20 cm row spacing with a sowing density of 140 plants/m^2 and 200 plants/m^2. Results showed that there was no significant difference in yield between sowing densities. Various seeding rates for spelt have been reported as optimal: a rate of 200 seeds / m^2 (compared to 100 and 150/m^2) was reported as optimal in a typical Mediterranean environment in southern Italy; whereas in central Saskatchewan it was found that the same seeding rate as common wheat (150 to 250 seeds/m^2) can be used for spelt. 100-125 plants/m^2 is a more common sowing rate for wheat in south-eastern Australia and is considered a better risk management strategy particularly when soil moisture is limited. Lower biomass production lowers the overall water required by the plant so that any soil moisture remaining can be utilised in making more or larger grains.

Calculating sowing rate

The following formula can be used to calculate sowing rates, taking into account:

- target plant density
- germination percentage (90% = 0.9 in the formula)
- seed weight. Weight will depend on whether the seed is hulled or hull-less, so this also needs to be factored into the calculations.
- establishment % – usually 80%, unless sowing into adverse conditions (80% = 0.8 in the formula).

Sowing Rate = 1000 seed weight[#;] + (grams) x target plant population (plants/m^2) ÷ 100 ÷ establishment percentage* x germination percentage

Example: sowing rate for spelt genotype ST1040

53.67 grams x 140 plants / m^2 ÷ 100 ÷ 0.8 x 0.9

= seeding rate 84.5 kg/ha

* Establishment percentage – 80% is a reasonable estimate, unless sowing into adverse conditions.

[#] to determine your seed weight, weigh 1000 seeds in grams;

[+]if the genotype is hulled then the hull weight (around 25-30% of total hulled seed weight) should be subtracted

Changing row spacing may have a more significant impact on yield however this was not measured in these trials. The impact of row spacing and plant population on the grain yield of wheat varies depending on a range of factors including cumulative temperature, starting soil water, total in-crop rainfall and especially, available soil moisture at flowering and grain fill.

Compared to wheat, the row spacing for spelt could potentially be increased due to its greater tillering ability (tillering coefficient 2-3 times greater than common wheat); however increased tillering has been shown to be at the expense of yield. In organic farming closer row spacing, particularly in higher yield potential situations, is the preferred option where increased ground cover can reduce competition from weeds.

Pest and disease management

Spelt is considered less susceptible to most pests and diseases which affect common wheat. Screening of spelt cultivars revealed mixed susceptibility to stem rust and stripe rust. The cultivars ST1040 and ST1041 were found to have variable resistance to stripe rust and stem rust.

There are currently no organic fungicides registered for use against stripe or stem rust in wheat.

In storage and at sowing, spelt's thick seed husk provides it with some protection from disease and storage insects.

Rotation management is important to minimise the risk of weeds, pests and diseases. Planting of continuous cereal crops should be avoided and break crops such as lupins or peas; or for longer rotations, legume based pastures, considered.

Harvesting and storage

Trials conducted by Industry & Investment NSW found that days to maturity varied significantly with spelt cultivars but generally they are longer maturing than common wheat. Later maturing spelt cultivars also yielded less and produced more crop biomass that earlier maturing cultivars. The research found that the days to anthesis for the commonly grown genotype Kamarah (165 days) was 15 days later than ST1040 and ST1041 (150 days). In comparison, the days to anthesis for EGA Wedgetail wheat was 145 days.

Harvesting spelt at the correct maturity is critical. Spelt rachis (where the spikelets grow) can be very brittle at maturity and delays in harvesting can lead to head shattering and significant yield losses. It was noted during field observations that ST1040 and ST1041 are slightly susceptible to shattering, particularly if not harvested at the correct maturity. Some literature suggests harvesting is best done before full maturity, (darkening of the spelt straw suggests it is overripe) in the early morning or at night when the humidity is greater.

Ideally, harvesting should be carried out when grain moisture content is 12% or less and at a slower speed and with a slower drum speed setting than for harvesting common wheat. A large amount of chaff is generated so slower tractor speed will also facilitate chaff clearance.

Many spelt cultivars are prone to lodging. If lodging does occur, avoid harvesting against the direction of the lodged spelt. Harvesting in the direction of the lodge will help to prevent 'picking up' any decaying plants and hence mouldy grain.

A trial harvest run is recommended so that correct harvester settings can be determined. Incorrect harvester settings can lead to damaged grain, grain loss - a large proportion of grain runoff with chaff, or grains not detaching from heads.

Storage should be at 12% or less moisture and, if hulled, with the hull retained. For prolonged storage, silos should be sealed and ideally with the capacity to inject carbon dioxide for insect pest control.

The Primefact 'On Farm Storage of Organic Grain' http://www.dpi.nsw.gov.au/agriculture/farm/organic/onfram-storage-grain provides details on storage options for organic grain.

Processing and marketing

Estimates of market size and returns for spelt vary considerably. Over the past 10 years annual production of spelt in Australia has averaged around 1,600 tonnes (Brown, G. pers.comm.2010). Drought has impacted significantly on the capacity to meet local demand and processors have relied heavily on importing spelt flour. Taking into account import replacement and growing demand for spelt products it is estimated there are markets for around 10,000 tonnes of spelt annually.

Figure 6: Spelt de-huller suitable for processing small volumes of spelt.

Spelt is largely processed into flour and then used in bread, cake and cookie mixes, pasta production, and a small amount into licorice production; or as whole grain rolled into cereals or as stock feed.

The exceptionally thick spelt husk makes it more difficult to process than modern wheat. Hulled spelt must be mechanically de-hulled just prior to milling. This additional step makes spelt more difficult and expensive to process than wheat. Processors require specific de-hulling facilities so a number of enterprises specialising in the processing of spelt have been established.

Some farmers' value-add and process on farm. Small volume de-hullers are available (pictured). Oat de-hullers are also effective but generally will only handle small volumes.

Most food-grade spelt is grown under contract with a processing company. Growers interested in producing a specialty grain will need to contact current processors for contract feasibility. (See Processor Contacts).

Spelt quality

In Australia, the main use for spelt flour is for bread making. The dough produced solely from spelt flour is characterised by lower stability, less elasticity, and higher extensibility than common wheat dough and tends to exhibit lower volume and a rather open coarse texture compared to wheat bread (Schober et al. 2002). Whilst specialist bakeries do produce bread made solely from spelt flour, common wheat flour is often blended to improve bread baking quality.

Figure 7: Rapid bake loaves, L to R: wheat, spelt genotype ST1069 and spelt standard 'Kamarah'. Photo: H. Taylor, Industry & Investment NSW.

Home baking with spelt flour

Home baking with spelt flour is popular. However spelt flour behaves quite differently to wheat flour. One feature of spelt flour is its ability to absorb water. This is further emphasised in 'timed' doughs such as sourdough, because spelt changes over time in terms of consistency. The website Sourdoughbaker (http://www.sourdoughbaker.com.au/ingredients/spelt-flours.html) provides some tips for the home baker.

Processor contacts

Blue Lake Milling Pty Ltd

Spelt (whole grain) flour, rolled spelt.
Contract processing – no direct farm purchase.
Pigeon Flat Road
Bordertown SA 5268
Phone: 08 8752 0111
Fax: 08 8752 2967
Email: lindy@bluelakemilling.com.au
Website:
http://www.bluelakemilling.com.au/index.shtml

Buckwheat Enterprises Pty Ltd

Spelt flour
Goobang Junction
PO Box 255
Parkes NSW 2870
Australia
Email: bio-oz@bigpond.net.au
Phone: 02 6862 5954
Fax: 02 6862 3580
Website: http://www.bio-oz.com.au/index.html

Casalare Specialty Pasta Pty Ltd

Gluten free organic pastas - baking mixes manufacturer.
37 Crichton Road,
Kyabram Victoria, 3620 Australia.
Phone: 03 5853 2366
Fax: 03 5853 2377
Website: http://www.casalarepasta.com/

Four Leaf Milling Pty Ltd

Spelt grain, flour, bran, flakes
Lot 120 Main Road
PO Box 83
Tarlee, South Australia
Phone: 08 8528 5330
Fax: 08 8528 5385
Website:
http://www.fourleafmilling.com.au/index.php

Junee Licorice & Chocolate Factory

Green Grove Organics
Organic spelt flour, spelt licorice
45-61 Lord Street,
Junee, N.S.W. 2663
Email: enquiries@greengroveorganics.com
Phone: 02 6924 3574
Fax: 02 6924 2999
Website:
http://www.greengroveorganics.com/178/Home/

Kialla Pure Foods

Spelt flour
342 Greenmount-Etonvale Road
Greenmount Qld. 4359
Email: reception@kiallafoods.com.au
Phone: 07 4697 0300
Fax: 07 4697 0399
Website:
http://www.kiallafoods.com.au/Default.aspx

Laucke Flour Mills Pty Ltd

P.O. Box 60
Bridgewater on Loddon VIC 3516
Phone: 03 5431 5201
Fax: 03 5437 3188
Mobile: 0418 857 576
Email: managerbwr@laucke.com.au
Website: http://www.laucke.com.au

Mirfak Pty Ltd

P.O. Box 38
Benalla VIC 3672
Phone: 03 5762 5077

Fax: 03 5762 5495
Email: catchall@mirfak.com.au
Website: http://www.mirfak.com.au/

Wholegrain Milling Company

Spelt grain, spelt flour
17-21 Borthistle Road
P.O. Box 347
Gunnedah NSW 2380.
Email: organics@wholegrain.com.au
Phone: 02 6742 3939
Website: http://www.wholegrain.com.au/

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