Crambe: A North Dakotan case study

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Abstract

Crambe (*Crambe abyssinica*), an industrial oilseed, has been successfully grown, processed and marketed on a commercial scale in North Dakota, USA, since 1990. A major reason for its success has been a multidisciplinary team involved in the research, development and commercialisation of the species through the auspices of the High Erucic Acid Development Effort (HEADE). Ecologically, crambe has offered a unique opportunity for farmers to diversify their crop rotations in North Dakota as it shares few pests with more commonly grown crops. It also shows tolerance to a wide range of insects and is produced using standard small grain equipment. However, crambe has one short fall; due to its low-test weight it is only economic to process it locally.

In recent years, the production of crambe in North Dakota has fluctuated as the commercial players involved in the industry have changed. Its future will depend upon both the future of biorenewable resources together with innovative research to develop additional markets for the crop. This paper presents a brief case study of the development of the North Dakotan crambe industry.

Key Words

Crambe, oilseed, new crop, case study

Introduction

Hundreds of crops have been domesticated and cultivated by humankind during the history of agriculture, utilised for food, forage, fibre and medicine. However, only a small number provide the bulk of the raw material necessary for human survival. The limited diversity has increased the vulnerability of crops to adverse climatic conditions and fluctuating markets. In recent years, particularly in Europe and the USA, there has been growing interest in the use of crops as biorenewable industrial feedstocks, for uses such as fuels, lubricants and bioplastics. *Crambe abyssinica* (crambe) is such a crop that has industrial potential.

The major aim of this small project was to compile a case study of the crambe industry in North Dakota, USA to determine how Australian grain industries could learn from the US experience of developing a new crop. It involved a brief study tour of key North Dakotan State University Research and Extension Centres involved in crambe research and development by the author supported by Rural Industry Research and Development Corporation together with the compilation of background information on crambe research, development and production in North Dakota.

Discussion

Description and uses of crambe

Crambe is a member of the *Brassicaceae* family and is native to the Mediterranean region. It originated in a warm-temperate area of Ethiopia with a moderate rainfall, but it has become adapted to colder and drier regions (1). In North Dakota, crambe is more resistant than canola to heat and drought at the end of the growing season, and, on average, crambe is the higher yielding crop (2). It has a short growing season taking about 85-100 days from sowing to maturity (3).

Crambe abyssinica has potential as an industrial fatty acid feedstock as a source of erucic acid. Erucic acid is used mainly as erucamide, an effective non-stick agent in polyolefin films for wrapping food, plastic bags, shrink wraps, lubricants, plasticisers and foam suppressants etc. It can also be converted to nylon 1313, or hydrogenated to behenic acid, which also has many applications in the manufacture of rubber, pharmaceuticals, cosmetics, fabric softeners, hair conditioners and rinses. Crambe oil is a very effective lubricant, and is much more biodegradable than mineral oils, so it may be used alone or as additives for the textile, steel and shipping industries.

History of the development of the crambe industry in North Dakota

Interest in the crop was first stimulated in the USA after the end of WWII in an effort to replace some of the commodity crops produced with specialty food crops or industrial crops to cope with US agricultures over production of commodity crops. A federal program begun in the late 1950s and led by the US Department of Agricultures (USDA) utilisation laboratory at Peoria, Illinois, screened more than 8,000 species, of which crambe was identified as a promising source of high erucic acid (4). This work led to the evaluation of crambe throughout the United States as a potential new crop with much of the initial agronomic research completed by 1966. USDA scientist Ken Carlson in Peoria led the utilisation and processing research necessary as a precursor for commercial development. Koert Lessman at Purdue and later at New Mexico State University maintained the breeding effort throughout the entire development period in conjunction with a federal germplasm effort led by George White and Austin Campbell at USDA facilities in Beltsville, Maryland (5).

Attempts to introduce industrial crops, to this point, had been very slow, often haphazard and inefficient (6). In fact, the first commercial attempt to produce crambe was unsuccessful in western Kentucky, USA during the 1981 season as agronomic test plots failed causing interest in crambe to decline as well (7). But the situation began to improve when a group of university scientists, private sector representative, and government scientists and managers focussed on rapeseed and crambe. This came about, when interest was revived in crambe during a meeting, held in Kansas City, Missouri in December 1986 organised by the US Department of Agriculture, through its Cooperative State Research, Education and Extension Services (CSREES) Office of Agricultural Materials and its Agricultural Research Services (ARS) National Agricultural Utilisation Research (NCAUR) and the University of Missouri's Department of Agricultural Economics. Along with Iowa State and Kansas State Universities and the Kansas Board of Agriculture, provided leadership for establishing the initial management structure, setting goals and developing action plans, primarily for commercialising crambe (6).

In 1989, the 'crambe project' sponsored a crush of 150 t of crambe seed produced in Iowa and successfully marketed the oil, which immediately increased both public and private sector interest in high erucic oil crops. In 1990, the project was extended to include industrial rapeseed and several additional universities. Thus the High Erucic Acid Development Effort (HEADE) was initiated.

A crucial event involved in the commercialisation of crambe eventuated when a group of North Dakotan farmers joined National Sun Industries (NSI) and North Dakota State University (NDSU) and HEADE from 1990 to 1995. In 1990 they produced 900 ha of crambe, and within four years the alliance had 24,000 ha of crambe under cultivation (6). At the same time, the HEADE team sponsored and conducted production, breeding, processing, product development and marketing research.

The US Congress provided partial funding for HEADE activities (less than USD $500,000) which were administered through the CSREES Office of Agricultural Materials to the participating universities under cooperative agreements. Each member university also provided funds and in-kind support for the research and commercialisation projects. The HEADE management committee established Requests for Proposals and peer review procedures to select 15-20 projects for funding each year. The government funding ended in the 1995 financial year, wherein the HEADE management committee completed the remaining funded research projects and encouraged project members to continue their institutional commitments to both crambe and rapeseed commercialisation. Internal funding and development of cooperative interactions with seed, biotech and chemical companies and with grower groups have

enabled several universities to continue breeding, agronomic, animal feeding and chemical research on both crops.

In 1995, the commercial development of crambe faltered again when the US Congress discontinued funding to the HEADE consortium and NSI announced a pending longterm lease of all its processing facilities, as the parent company had shifted its business focus. However, the grower group, now numbering some 540 growers (the American Renewable Oil Association) began shopping around for other processing/marketing partners in their region. The growers found the local oilseed processing industry very helpful, making its facilities available for toll crushing if the growers would shoulder the risk of contracting the production and marketing the oil and meal of the small volume niche oilseed (5).

The growers decided to establish their own value-added business. This was a concept not entirely new to North Dakotan growers as they had been very successful in establishing value-added industries for durum wheat for pasta, sugar beets and corn for sweeteners and buffalo for low-cholesterol steaks. They established a company called AgGrow Oils LLC which was headed by John Gardner, formerly director/agronomist for the NDSU Carrington Research Extension Center. John Gardner had been involved with the development of crambe right from the start of the venture in North Dakota and is considered by some to be the ‘Father of crambe’.

AgGrow Oils LLC was a fairly ambitious processing and marketing effort that attempted to take advantage of the mega-processing companies' biggest weakness - their inability to react quickly to change, in the market and on the land. They were also involved in other niche crops such as safflower, borage and canola.

Originally crambe had been processed by National Sun Industries at its Enderlin plant in North Dakota and NSI also marketed the oil and meal. In January 1998 a 200t/day oil processing facility for niche specialty oils opened in Carrington, North Dakota, a joint venture between AgGrow Oils LLC and Cenex Harvest States Cooperatives involving some 540 growers (7). However, this facility is no longer in operation as a specialty oil crushing facility as it was sold to a local company for use as a packaging plant for birdfood and other nonoil seed commodities in 2001. The AgGrow Oils venture lasted only two years, however, the grower group, American Renewable Oil Association, is still active today.

In 2000 and 2001 the Montola Oilseed crushing facility in Culbertson, Montana was utilised by the crambe grower consortium. This facility has a capacity of 300 t/day. In November, 2001, Harvest States, a division of Cenex Harvest States Cooperative, dropped its plans to buy the crushing facility which had been owned by Sheridan Electric. At this point in time, it is unknown what the status of this facility is.

In February 2000 a new commercial interest moved into the crambe scene in North Dakota, John K King & Sons Limited, an English company owned by Allied Grain (a wholly owned subsidiary of Associated British Foods PLC, one of the UK's leading companies, and the country's largest agri-food business) opened an office in Carrington, North Dakota. In 2000, Kings set a 30,000-acre goal for contracting crambe production in North Dakota, in competition with AgGrow Oils. Kings utilised Archer Daniels Midland plant in Enderlin, North Dakota to crush the seed. In 2001 they contracted 11,000 acres but reportedly will did not offer contracts in 2002 as they are had problems filling their required 20,000 acres. Kings now competes with Cenex Harvest States for the current production of the crop in North Dakota.

Production of crambe in North Dakoata

Crambe production in North Dakota has fluctuated from 23,000 ha in 1993 to as low as 500 ha in 1995 (Figure 1). Over production in 1993 and 1994 led to the low production in 1995. This was possibly also linked with the discontinuing of the HEADE investment and the change in nature of NSI’s business. There are reports in the literature that the 1995 production was purely to maintain seedstocks (5).

The main regions for production are the drier western third of North Dakota. At one time, when crambe production first started, most of the production was in the higher yielding eastern part of the sate but as

North Dakota entered a wet cycle the production shifted to the west where disease incidence was lower. The growing season in this area is from May to September with on average 320 mm rainfall and around 120 frost free days.

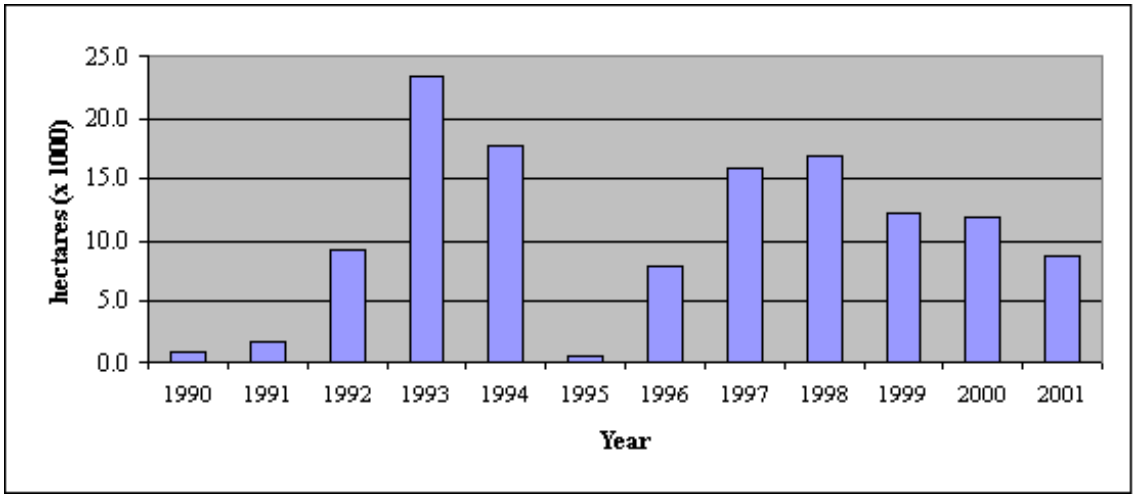

Figure 1: Crambe production (x 1000 ha) from 1991 to 2001 (figures from North Dakota Agricultural Statistics Service and North Dakota State University Research and Extension Centre)

The main crop species produced in North Dakota are quite diverse and wheat is the dominant crop, followed by barley, soybeans, sunflower and canola. The dominant oilseeds are soybeans, sunflower (about one quarter of the production is utilised for non-oil purposes) and canola. The production of canola has expanded quite considerably in recent years. The production area of crambe in North Dakota is comparable to other niche crops such as rye and lentils. In recent years prices for crambe have been around USD$135t^{-1} with government subsidies bringing it to around USD $219t^{-1}.

Conclusion

This brief case study of the North Dakotan crambe industry provides many incites into the development of a new crop that Australian growers and researchers could learn from. Its success was fostered by a crop champion, together with the sharing of risk among producers and processors, each with visions of the potential benefits of commercialising an alternative crop together with the considerable work of a multidisciplinary team.

Although crambe seems to have found a niche in North Dakota, its production is still far from secure and will obviously depend on the future of biorenewable resources not only in the USA but world-wide. However, in the mean time North Dakota has gained a wealth of experience with the crop in the state, and this would have not been possible without the university, industry, and the creativity that the North Dakotan farmers possess.

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