CONTRACEPTION, CHARCOAL AND COWS:

THE WORLD OF BREWERY CO-PRODUCTS

In my married life I have encountered two extremely effective contraceptives. The first was a beard (see p27); the second is Marmite.

As the world knows, you either love it or you hate it (Marmite, that is - and my antipodean friends say the same thing applies to Vegemite). It, of course, depends on whether your mother had a mean streak. If she did, and stuck her finger in this jar of thick treacly stuff before plunging it into your mouth, then you grow up adoring it. If, however, your mother was anything like mine then there was ne'er a jar to be had and I grew up with a mild, bordering on vehement, dislike for it. My dear Diane greatly relishes it, especially spread thinly with butter on hot toast. I do not kiss her until she has cleaned her teeth and rinsed amply with mouthwash.

A century of icky sticky stuff

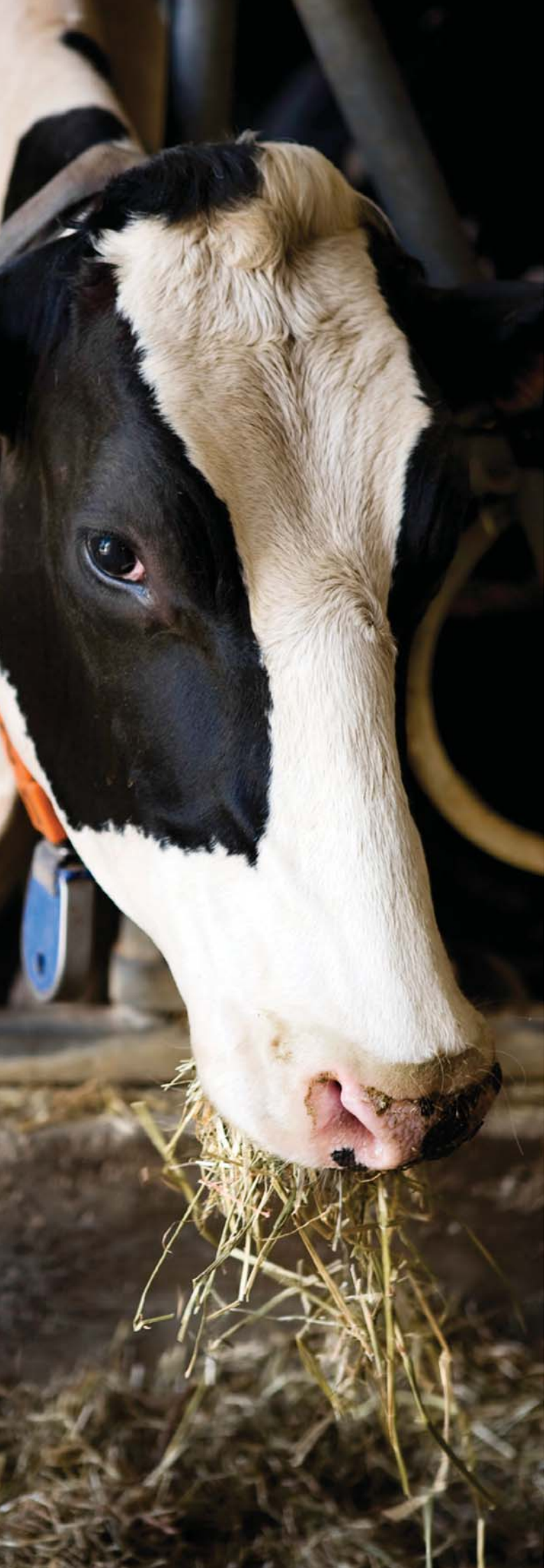
Such indeed is the very basis of the Marmite folks' marketing strategy, so I have no difficulty admitting my distaste for it. That the savoury concoction has been around for so long – the Marmite company first started spewing out that distinctive aroma over Burton-on-Trent in 1902 – speaks to the fact that there are an awful lot of folks who relish it, not only for its flavour but also because of its nutritional merit, notably its content of vitamins. The company who now makes it – part of Unilever – boast that it tastes better than vitamin pills. But I wouldn't know: I get my vitamins from a well-balanced diet, inclusive of a more palatable form of folate and such forth, namely beer itself.

Pie-eyed pigs

Marmite, of course, is basically autolysed yeast. And the trucking of surplus yeast to the yeast extract folks has long been a reliable and relatively valuable outlet for this substantial co-product of brewing. It is by no means the only opportunity. Distillers continue to call upon brewers for yeast, being less fastidious about the strain than brewers. Even more common has been the use of yeast as a feedstuff for animals. I well recall pitching up (if you will excuse the pun) at the Shepherd Neame brewery in Kent many years ago, just as the sluices opened and the yeast slurry arrived for the pigs. Never since have I heard such squeals of delight. Tasty stuff, plenty of nutritive value, including the cell wall fibres, and the alcohol made them some of the happiest porkers to be found that side of Old Trafford.

Bloody good idea

No shortage of opportunities for surplus brewing yeast, then. But when I was at Bass we weren't (of course) satisfied with the status quo and were constantly in search of something new and novel. Many was the hour (usually fuelled with Worthington White Shield) that we would gleefully brainstorm this area and many more potential opportunities to extend the margins. Some were distinctly out of left field. It was our gaffer, Tony Portno, though, who came up with the idea that was quickly transformed into a laboratory spin-off in Nottingham which quickly outgrew the research team that we had in Burton. (And by brewing standards that of itself was fairly formidable at more than thirty folks – ah! the good old days!!) This offshoot was Delta Biotechnology and the idea was relatively straightforward in descriptive terms if not in practical reality: to introduce genes for high value proteins into brewing yeast in forms that were only switched on after the brewing process. So the concept was to ferment beer in the time honoured way, harvest the yeast, add the trigger for the added gene of interest and then recover the protein and run to the bank. In particular the protein that was focused on was human serum albumin and I can see the headlines in the *Financial Times* now: Bloody Good Beer. The concept was startling in its simple sophistication but to the best of my knowledge there was never a drop of the stuff made in this way. It was quickly realized that the economics were far more attractive if you used an artificial medium from the outset rather than wort, and that brewing strains are really rather tough little beggars to genetically modify



when compared to haploid yeasts or certain bacteria. Delta was sold and has been through several sets of hands since, most recently to Novozymes.

What business are we in?

The idea behind Delta was exciting indeed. However, let us beware. If we are not careful then the tail wags the dog. At the moment all of the co-products from a brewery, notably the spent grains (with trub usually mixed in) and the yeast, are very much secondary streams. Their sale or, in the worst case, disposal to waste is a necessary evil to allow the main business at hand, namely the brewing of beer. Were it the case that a use is found for either material that is more valuable than the beer itself then the whole raison d'être would change. Dare we even ponder a brewery where the beer is almost an afterthought? Too silly to contemplate? Perhaps not. In the world of cheese-making, the exciting uses for the co-product whey (such as converting it into a protective coating for many foods) can make it an even more valuable commodity than the cheese itself.

What more can be done?

Presently, most brewers seem to do tolerably well in disposing of their surplus grain to cattle feed. That is, those who have cows close to hand or farms close enough for ensiled grains to be delivered in good time. It has, however, long been prudent of brewers to identify alternative opportunities for spent grains usage, always remembering that it seldom makes economic sense to dry an 80% moisture commodity that I estimate is generated at a rate of somewhere between 20 and 30 million tonnes per annum worldwide. Spent grains spoil with rapidity unless they are treated with acids such as lactic and acetic or with the preservative potassium sorbate. If they are dried then the temperature used can be no higher that 60ºC if the risks of charring and burnt flavours are to be avoided. One suggestion has been to use superheated steam, with environmental advantages and the preservation of valuable organic compounds (*Journal of Food Engineering* 67, 457–465). Others have pressed the grains to 20-30% moisture (*Separation Science and Technology* 39, 3237–3261).

It would appear that spent grains may be a useful feedstuff for more than cattle alone, fish for example (*Bioresource Technology* 91, 101–104) and craft brewers with restaurants have long hawked spent grains as part of their dinner breads, to which they impart enhanced nutritional value (*Die Nahrung* 37, 576–582). All that lovely fibre (*Journal of Cereal Science* 42, 1–13). One advance has been to separate the grains by a milling and sieving technique to yield a material claimed to be a

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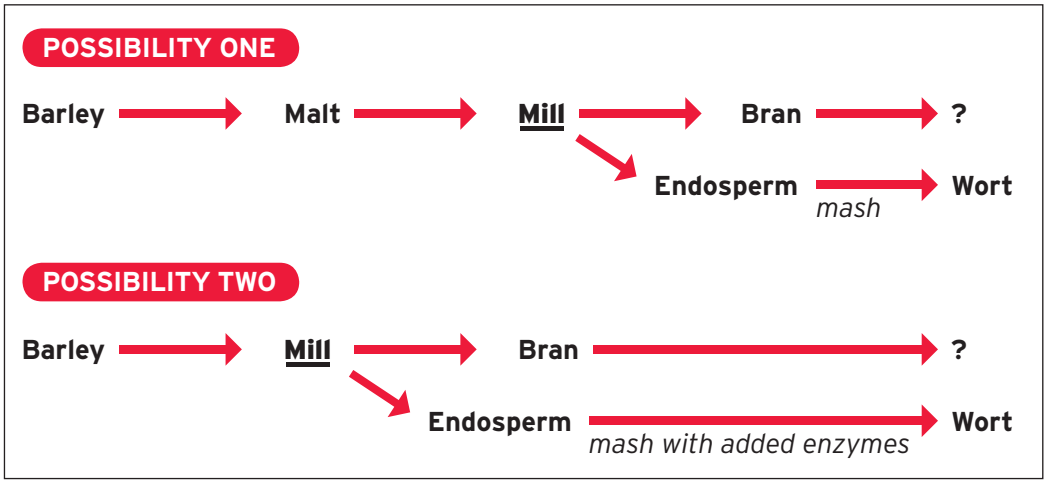

Figure 1: New paradigms producing "dry spent grains"
Option one involves malt as the starting point; option two unmalted grain

great pre-biotic for those suffering from ulcerative colitis (*Bioscience, Biotechnology and Biochemistry* 61, 29–33).

Spent grains are indeed a great source of fibre, being big-time in cellulose and arabinoxylan coming from the unhydrolysed husk and bran of the grain. The bulk of the grain's silica, too, ends up in the spent grains, despite the fact that enough enters into beer as to make the latter one of the richest sources of the stuff in our diet.

More than food

Food-schmood. Spent grains might be used for much else besides. They have been used as substrates in the production of enzymes (*Thai Journal of Agricultural Science* 11, 209–222) and of the highly prized antioxidant ferulic acid (*Journal of Cereal Science* 25, 285–288), as well as the sweetener xylitol (*Process Biochemistry* 40, 215–1223). They can be fermented to yield burnable biogas (*Process Biochemistry* 31, 7–12). They can be converted into charcoal bricks (*Kagaku Kogaku Ronbunshu* 28, 137–142): what a perfectly symmetrical barbeque that would be; to have steaks from spent grain-fed animals grilled on spent grain briquettes and washed down with beer.

Grains have been made into bricks (*Construction and Building Materials* 19, 117–126) and paper (*MBAA Technical Quarterly* 37, 261–265). They have been used as an adsorbent in a comparable way to charcoal (*Journal of Hazardous Materials* 31, 19–28).

Left, the author circa 1980. Scary. Right, the author in November 2008 with grandson Aidan William Bamforth

PROFESSOR MICHAEL J LEWIS FUND

Many North American brewers started their careers at UC Davis under the tutelage of an inspiring professor who taught the craft of brewing.

For more than 30 years, Professor Michael J Lewis led the UC Davis Brewing Science curriculum, building from an idea to a program with a worldwide reputation for excellence. So many undergraduate and Masters students and, latterly, numerous extension students have benefitted directly from Professor Lewis' wisdom and experience.

To recognize the many contributions Professor Lewis has made to his students and to the brewing industry, we have created a new endowed fund, named in his honour, and dedicated to supporting brewing science students at UC Davis. Students who have been taught by Michael and all others who recognize his many contributions are invited to participate. For more information, contact Charlie Bamforth at cwbamforth@ucdavis.edu

Logic

All in all, a remarkable breadth of opportunity. And yet the fact remains that it all boils down to balancing the economics. To what extent does the demand for these various outlets marry with the rate of grains output from a brewery? And just how attractive are grains really? This soggy stuff is considerably less appealing for taking into a factory than a nicer dry material – say, barley or malt.

And therein surely lies the rub for the future. Far more logical would be to create the "spent grain" before brewing (*Figure 1*) by selectively milling the grain into the bran and endosperm fractions, diverting the former to wheresoever you can get the best bang for your buck and the latter to what our game is really all about: making beer. Sure, it would demand a re-think of brewhouse equipment, but I would contend it would make for a more profitable and environmentally sustainable business.

And it would do nothing to alienate Marmite aficionados, such as our son Peter, born 28 years ago and obviously nine months after Diane had steered clear of the black jar. To the best of my knowledge, Peter's son Aidan has not yet been exposed to his father's favorite spread. His American mom, Stephanie, is not a fan.