Adding value through processing

Dr Mike Matthews

This paper was presented at the 2017 NZIFST conference in Nelson. Dr Matthews is a food industry consultant and was CEO of the Tatua Cooperative Dairy Company, 1995 - 2008. He is also a Director of Food Industry Enabling Technologies (FIET).

"Added value" is a catch-all term for products that are more profitable than commodities. To earn this sought-after status, products must improve profit margins and do so sustainably. Of course, everyone wants improved margins, but better margins than what? If we use the dairy industry as an example, does this mean that skim milk powder and anhydrous milkfat products are bad, and added value products are good?

Added value is not part-time

The margin gap between commodities and added value products is not always clear-cut and can sometimes disappear altogether. A company's commitment to add value through new products can wilt when commodity prices soar. Not all companies are willing to forego commodity-driven windfalls, which is fine, that is their call. However, when commodity prices sing their siren and prices soar, companies cannot abandon their added value strategy. Added value cannot be part-time, we cannot come and go from this kind of business, at least not for very long.

There is also the pesky fact that companies that add value often rely on commodities as a platform, partly for ensuring their own supply of raw materials, but also for helping carry the weighty burden of fixed costs. The more you can share costs across both commodities and added value, the better. For example, I am quite sure that there is no way that the 21 billion L of milk produced in this country every year is destined for added value products.

Does added value always mean new, somehow fancier, more sophisticated products? This is an interesting question. In the more attractive embodiment of the term, it certainly does, but I believe we need to broaden the concept.

How can added value be achieved?

In all cases of added value initiatives, there must be an enhancement or improvement of some sort, for example:

- Higher net profit versus commodity use of same quantity of raw material
- Ability to retain a market/customer that might otherwise be lost
- Improved product safety
- Better process economics
  - Higher throughputs
  - Better yields
  - Reduced variable costs
  - Ability to spread fixed costs over expanded product range from same assets
  - Ensuring that the ability to carry fixed costs and meet the imposts of interest and depreciation on profit and loss accounts are not impacted, which will occur, for example, by having capital assets sitting idle
- Ability to gain market share and get new customers
- Better credibility/reputation with markets and customers
- Better access to markets through
  - better quality
  - more competitive pricing

Process improvement or new products?

It would be easy to limit this discussion to how new technologies can lead to new products but adding value through processing can also apply to an improvement in an existing process. Industry history has shown us that adding value through product innovation, which often involves process changes and new equipment, is the harder, riskier and the more resource-hungry path.

When there is a clear-cut economic benefit and the risk is low, most companies do not need much persuading to improve existing products and processes. Convincing a Board to invest in new products and processes, however, with all the attendant risks requires additional rigour and courage. The only way to ensure that a Board keeps supporting new product initiatives is to make sure that projects supported to date are making money.

Added value through new products is not for fair weather sailors. That said, the rewards are real, provided those who adopt such a strategy are clear-headed and understand what they are doing. It goes without saying that strong financial analytical capability is just as important as the science and technology that underlie added value success.

Some companies have a history of concentrating on the former, some on the latter, and in some happy cases, they pay substantial attention to both.

Generating genuine and sustainable profit.

For cooperative companies, this means increasing distributable earnings to farmers

Payout = Total revenue less total costs less retentions

If we use the dairy industry as a example, total payment to farmer shareholders for the primary base comparator, Fonterra, has two elements:

- A milk payment, which derives from a basic set of commodities
- A profit, which is essentially the profit that derives from Fonterra's added value activities, payable to fully paid up farmer shareholders

For example, a total payment might comprise of a milk payment of $6 plus a profit of 50 cents, to give $6.50/kg milk solids. In Tatua's case, no attempt is made in any formally reportable sense to distinguish profit that derives from milk versus added value products, although the Company itself is well aware of what these are – it has to be. Tatua's announced payout is all revenue minus all costs minus any money (retentions) held back to maintain or enhance the balance sheet. All

shareholders are fully aware that they participate in all investments made by the Company, so there has never been any clamouring to distinguish between margins generated by one or by the other. Given that Company resources – both staff and equipment – are employed in making both commodities and added value products, it is not always straightforward to allocate costs cleanly and neatly to one product set or the other.

As a further complication, what is a commodity and what is added value? Fonterra, for example, counts caseinates and whey protein concentrates as added value. Tatua counts them as commodities, so it all gets a bit blurred. In the end, it all comes down to how much money is paid to shareholders and whether their investments in total are generating income for farmers that they are happy about.

What does value-added mean?

Now let's examine the word "process" in more detail and see if we can tease out what we mean by "value-added" processing.

A process is a sequence of steps, or unit operations, that in aggregate transform raw materials into finished products. We can refer to an entire process, such as cheese making, but we can also refer to each unit operation within the total process, such as milk separation, or curd formation, or Cheddaring, or packaging, as a process or a process step.

From time to time, added value is created when a newly developed processing technology is combined with existing processing steps to create a new product. A very good example is ultrafiltration. Combining the then new process of UF with well-established unit operations of clarification, evaporation and drying in the 1970s led to a set of products that now generate over $1B worth of revenue for the country.

Examples

What examples could we consider to be added value through processing in the dairy industry? We can cite many historical examples of technologies or bodies of scientific knowledge developed or adapted in New Zealand.

1. Vacreation, the process for steam stripping volatile odours from cream, which led to longer shelf life butter of less intense cowy or barny flavour for the UK market
2. Continuous production of cheese curd for dry salt varieties such as Cheddar
3. Phage control in cheese making
4. Making Mozzarella cheese that is ready for use on the day of manufacture
5. Fractionating milkfat into low and high melting point fractions
6. Increasing lactose yields by smart redesign of evaporators to make highly concentrated lactose solutions prior to crystallisation
7. Fully automated packaging, palletising and storage of milk powders
8. Precise control of spray dryers to maximise powder yield and quality

Other value adding technologies have resulted in new products, made possible because of new process steps introduced into existing plants. For example:

1. Membrane processing such as reverse osmosis for water removal, ultrafiltration for making whey protein concentrates and microfiltration for making low-fat protein isolates
2. Ion exchange for whey demineralisation and various protein purifications, e.g. for whey protein isolates and lactoferrin
3. Solvent extraction for recovering specialised fat fractions from milk fat globule membranes for use in nutritional products, notably infant formulas
4. New chromatographic/ion exchange processes for isolating bovine milk oligosaccharides from whey
5. Use of enzymes and co-development of hydrolysis process equipment to modify milk components such as lactose (to make lactose-free milk), protein (to make peptide digests for specialised nutrition) and milkfat (to make flavour concentrates)

Success factors

Introduction of new processes almost always brings disturbance. Some companies are much better than others at predicting issues and achieving success. Success is often characterised by a combination of:

1. Having a company culture that is attuned to added value and that understands the need for product and process development
2. A good project team, well led and including a good mix of people who have particular knowledge and enthusiasm for what the project is all about
3. Attention to staff recruitment and training
4. Having a Board and management that knows that new product and process initiatives almost always take time
5. Strong understanding of the raw material to be processed: analytical composition, physical characteristics, seasonal variability
6. Clear understanding of target product specifications and what customers expect
7. How to analyse the end product and how to interpret results

8. Strong technical understanding of the technology and processes they are about to install
9. Understanding of how the raw material and the process to be employed interact
10. A well-developed plan on how to integrate a new process into their plant
11. Clear targets for yields and throughputs, driven by accurate mass and energy balances
12. Having confidence in advance that utility requirements have been provided for, in particular peak draw offs of steam and power

This can be distilled to just one phrase: an **enabled** organisation. This means having a supportive Board and great staff who embrace the company culture. If the staff are good, good things follow – they like (and learn a great deal from) customer contact, they love seeing their company succeed, they watch out for new technologies, they monitor performance and they feel badly if they fall short of expectations, which they try very hard not to do. When you have such a workplace, well networked with its markets, initiatives in new products and new processes will follow.

Pathway to failure

On the other side of the ledger, what characterises companies that have wanted to get involved in added value products but have failed to achieve success? These include failure to have:

1. A clear idea of what it is you want to make, backed up by market research
2. An understanding of the raw material to be used:
   a. Reliability of supply, especially if you have to buy it from another party
   b. Consistency
   c. Characteristics, especially concentrations of target components, and how to measure them
   d. Cost of raw material per kg of finished product
   e. Microbiology
3. Knowledge on how the raw material and the new process interact
   a. Intended process parameters
   b. Process stability with time, during day but also over longer periods
4. A plan to integrate the intended new process into an existing plant
5. Thorough mass and energy balances to tell you:
   a. Yield
   b. Throughput
   c. Production, per day, per year
   d. Utility requirements (gas, steam, water, power, air, per hour, per day and peak instantaneous loads
   e. Waste streams to be dealt with
6. A well-prepared risk and hazard analysis
7. A thorough, credible financial analysis
8. A staff analysis that identifies the people resources needed to really make value-added a success, without increasing salary costs so much that value added margins are negated

A particular challenge: microbiology

New technologies can also bring new risks, for example microbiological. We all know that milk is a superb growth medium for microorganisms but sometimes I worry that large modern plants and the technologies they employ are failing to fully take this into account. It has long been a mystery to me why our industry was so reluctant to embrace within-process refrigeration, and it is also a mystery to me, why some plants have run for far too long before they are cleaned.

Some technologies such as membrane processing and ion exchange have huge food contact surfaces, all the better to do what they are designed to do but with considerable potential to act as growth surfaces unless they are scrupulously monitored and cleaned often. Even some of the long-established machinery such as separators and evaporators in their modern forms can be run in such a way that leads to biofilm formation. These biofilms can be hard to remove during CIP. As they expand in area, they can slough off bacteria, which can lead to the occasional "spiking" of powders with annoyingly random out-of-specification counts, a phenomenon I have seen in several plants, and not just in New Zealand.

New equipment and indeed new processes need careful hazard analyses. Be sure your company does them and documents them and that you have good operating procedures in place to avoid foreseen problems.

Conclusion

The dairy industry has such a fine history of innovation – never let anyone tell you otherwise. I still believe it is one of the best "meal tickets" in this country for career-minded young people, with loads of opportunity, especially in areas that require innovation. Every year brings new knowledge about the amazing raw material that is milk and the amazing animals that produce it. It is exciting, to be sure, but we just need to make sure that the basic processing disciplines that have served us well are applied rigorously.

FIET
Food Industry Enabling Technologies

Food Industry Enabling Technologies (FIET) is funded by the Ministry for Business, Innovation and Employment and its purpose is to support new process developments that have the potential to add significant value to our national economy. The programme has six partners, Massey University (the host), Riddet Institute, University of Auckland, University of Otago, Plant and Food and AgResearch. The board is chaired by Dr Kevin Marshall and there are currently ten projects. Funding is $18 m over six years. The Board is chaired by Dr Kevin Marshall, with Dr David Tanner, Professor Pare Keiha, Dr Peter Fennessy and myself as Directors. Funding is for $18 m over six years (2015-2021) and targets pre-commercialisation activities.

The initial three-year programme consists of ten projects.

1. Improved on-farm refrigeration systems and milk vat design
2. Rapid freezing of milk on farm for enhanced product quality and better transport
3. Meat tenderisation
4. Development of efficient and controlled processes for making smoked foods
5. Meat liquefaction
6. Apple pomace fracturing
7. Spray drying of high sugar products
8. Atmospheric freeze drying
9. Pulsed electric field and high-pressure processing
10. New technologies for pasteurisation and sterilization

Projects are currently at the halfway stage and about to enter the 2nd triennium of the programme. As you might expect, progress amongst them is mixed – some are going well, others less so – but there is no doubting the need for New Zealand to be a very strong player in the application of new technologies in the food industry. The FIET initiative targets pre-commercialisation activities. Any business investments that follow would be the responsibility of commercial firms.

What does "added value" mean within the context of the FIET programme?

The most obvious meaning is that a project will generate an acceptable and material financial return on funds employed. The primary measure is therefore financial but there are other assessment criteria. Selection criteria typically include:

[1] Financial

Achieves or leads to:

- Material economic value
- New capital investment
- Increased employment
- Improved production efficiency
- Increased raw material demand
- Overcoming of shortfalls or risks in existing technology
- Lower utility consumption (water, energy)
- Diffusion of wealth throughout communities
- Multiplier effects: i.e. gives spin off benefits to other companies and industries
- Better utilisation of the country's services: e.g. transport, banking, finance, insurance, engineering, machinery fabrication, education, training, analytical, legal

[2] Regulatory

Enables compliance with:

- New Zealand's laws and regulations
- Environmental standards, current and future
- Safety standards
- Labour laws
- Applicable laws/standards in target international markets

[3] Marketing

Enables creation of, or leads to:

- New products and new markets
- New demands and new opportunities
- Improved ability to compete with other countries
- Meeting the expectations and demands of buyers e.g. supermarket chains
- Protected intellectual property

[4] Social/national agenda

Enhances:

- Labour skills
- Understanding of new technology and how it can be used more widely
- Technology education
- National competitiveness
- International standing

I commend enquiry and dialogue with FIET management from parties that could benefit from funding under the FIET programme umbrella.

The FIET programme will undergo a mid-term review in late November. The purpose of this review will be to assess and select a suite of projects that could add value through processing. If you are interested in more information, then please contact either Dr Jo Kerslake, FIET Programme Director (j.i.kerslake@massey.ac.nz) or Professor Richard Archer, Chief Technologist (R.H.Archer@massey.ac.nz). Further information about FIET can be found at fiet.ac.nz