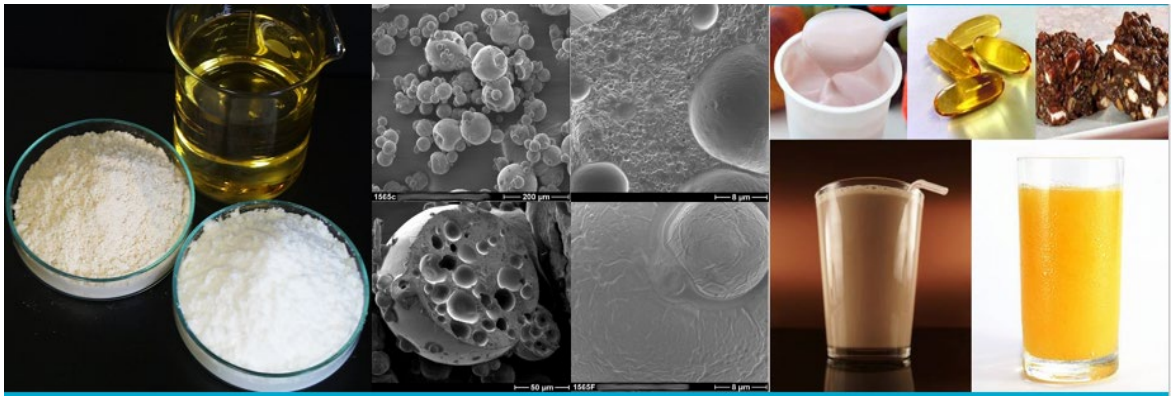
Microencapsulation Technology

Impact Evaluation

May 2020



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1 Executive Summary

Background

There is growing interest from the consumers for functional foods which can promote their health, and this has given rise to a growing number of functional foods on the market. There are technical challenges in manufacturing functional foods containing health-promoting components, which are often labile. Instability (leading to short shelf life), sensory unacceptability and limited bioavailability present some of the key challenges associated with the formulation and processing of some highly nutritious/ efficacious ingredients. This limits their utilization for functional foods and pharmaceutical applications while creating other issues with their handling and transportation. Such labile components need to be conserved during storage, cooking and consumption and delivered to the right part of the body to maximise their health benefits.

The challenge

With the world transitioning from an era of traditional to functional foods there is a need from food manufacturers for affordable technology that will protect labile health-promoting components of functional foods.

The response

CSIRO developed MicroMAX® suite of technologies (1999 -2019) for microencapsulation of bioactive nutrients and protect them from degradation during processing, storage and gastro-intestinal transit. The goal was to enable the incorporation of nutritious (but unstable) ingredients in the food items while allowing sensory acceptability and masking undesirable flavours for intended applications.

CSIRO's MicroMAX® 1 (first generation microencapsulation technology) - the most successful commercial adoption case from this program, was licenced by Clover Corporation (CLV). The technology was used to microencapsulate and stabilize micro-encapsulated powders rich in Docosahexaenoic acid (DHA; a type of omega 3 lipid) and enable their incorporation for dry blending applications. The patented technology allows up to double oil loading with superior odour, taste masking and extended shelf life compared to competitive products.

Continued development of the microencapsulation technology has been used to deliver other oil-soluble healthy components and pre and probiotics.

The impacts

CSIRO's MicroMAX® innovation has led to new benefits and opportunities in many nutritional food ingredients for the food industry. The suite of technologies is proving to be a game-changer in providing nutritional options that have the potential to significantly improve the health and wellbeing of the community.

The economic assessment for this study focuses on the commercial adoption of MicroMAX® 1 by Clover Corporation to microencapsulate nutritional oils. CLV's superior DHA powders are sold to many leading infant formula manufacturers in Australia, New Zealand and globally; and internationally recognised as the benchmark for quality and stability

By examining the producer surplus benefits from demand and sale of DHA powders manufactured using MicroMAX® 1 technology, our estimates suggest (real PV @ 7% discount rate; or ROI; actual period for analysis is 2006-2027; however, there is no data available for 2006-2009 (incl), see Section 5):

- Net Present Value of $110 mil (2019$$) for CLV from demand and sale of DHA powder globally, with $35.1M attributable to the contributions of CSIRO for the assessment period
- Benefit- cost ratio of 3.3 for the program

B2B and B2C customers provide opportunities for future impacts. The overall investment of $24.6M (nominal) has been utilized to develop a suite of technologies. The reported benefits relate to the original MicroMAX® 1. With the recent licence acquired by CannPal and active engagement with industry for commercialisation of MicroMAX®-Pro (any further information is confidential at this stage); there is the likelihood of more benefits in coming years.

Table 1: Impact assessment of Microencapsulation Technology program: Key summary items

<table>
<tr><td>Timeline</td><td>Costs</td><td colspan="2">FY1999- FY2014</td><td>Benefits</td><td>Ex-post: FY2006 to FY2019
Ex-ante: FY 2020 to FY2027</td></tr>
<tr><td>Financial Investment (FY 1999-FY2019; in FY2019$$)</td><td>WDWL</td><td colspan="2">Overall: $ 29.5 million (nominal)
CSIRO: $ 9.48 million (nominal)</td><td>WODWL</td><td>Overall: $ 24.6 million (nominal)
CSIRO: $ 7.9 million (nominal)</td></tr>
<tr><td rowspan="5">The Impact</td><td colspan="5">Impact Type: For Summary of Impacts as per CSIRO's triple bottom line (TBL) Benefit Classification – Table 3</td></tr>
<tr><td colspan="2">Economic</td><td>Environmental</td><td colspan="2">Social</td></tr>
<tr><td colspan="2">- National economic performance
- Trade and competitiveness
- New services and markets</td><td>- Lower environmental footprint of production</td><td colspan="2">-Health and wellbeing
-Better quality of life
-Innovation and human capital</td></tr>
<tr><td colspan="2"></td><td>Overall Investment</td><td colspan="2">CSIRO Investment</td></tr>
<tr><td colspan="2">BCR</td><td>3.3</td><td colspan="2">3.3</td></tr>
<tr><td colspan="2">NPV (in mil, 2019 $$)</td><td>110</td><td colspan="2">35.1</td></tr>
<tr><td>Business Unit(s)</td><td colspan="5">CSIRO Agriculture and Food (A&F), Health and Biosecurity (H&B)</td></tr>
<tr><td>Key roadblocks hampering uptake and adoption</td><td colspan="5">-A lead science and business champion for technical advancement and driving uptake
- Strategy and BD planning
-Internal and external collaboration
-Internal investment strategy
See Section 9 Recommendations for more details</td></tr>
<tr><td>Prospective Future Impacts</td><td colspan="5">Opportunities are both for B2B and B2C customers. New products, market niches and services in food, pharmaceutical, agricultural and medical industries. For e.g. medical and preventative health foods, shelf-stable powders, beverage containing probiotics, Stable krill oil powders and emulsions</td></tr>
<tr><td>Underpinning Background Research</td><td colspan="5">- Microencapsulation work (started in 1996 at CSIRO and Australian Food Industry Science Centre (AFISC))
- Clinical trials to substantiate health outcomes (post 2000)</td></tr>
<tr><td>Confidence Rating in assessment</td><td colspan="5">Low-Medium</td></tr>
<tr><td>Collaborators and sources to corroborate Impact</td><td colspan="5">Clover Corporation Ltd (CLV), Pharmamark, NutriV, CannPal</td></tr>
<tr><td>Economic Assessment validated by</td><td colspan="5">Dr. Leo Dobes, ANU</td></tr>
<tr><td>Further Information</td><td colspan="5">Research Case Study: Mary Ann Augustin , Lloyd Simons
Impact Evaluation: Anne-Maree Dowd , Harmeet Kaur</td></tr>
</table>

**This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework to the CSIRO's Microencapsulation Technology case study are summarised in Figure 1*

.

Glossary and Notes

A&F	Agriculture and Food
AFISC	Australian Food Industry Science Centre
B1	Benefits from higher MicroMAX® based powder price (DHA- a key ingredient)
B2	Benefits from price premium for final infant formula product
B2B	Business to business
B2C	Business to customer
CAGR	Compound Annual Growth Rate
CannPal	CannPal Animal Therapeutics Limited
CBA	Cost-benefit assessment
CLV/ Clover	Clover Corporation Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVD	Cardiovascular disease
DHA	Docosahexaenoic Acid
DWL	Dead Weight Loss
EPS	Earnings per share
GI	Gastrointestinal
H&B	Health and Biosecurity
IP	Intellectual Property
JV	Joint Venture
MM	MicroMAX
NPAT	Net Profit after Tax
NPV	Net present value
Nu-Mega	Nu-Mega Ingredients Pty Ltd
PL	Phospholipid
PoC	Proof of concept
PV	Present Value
ROI	Return on Investment Ratio
Veg	vegetable
VegPro	Vegetable & Probiotics
WDWL	With deadweight loss
WODWL	Without deadweight loss
wrt	With respect to
Unless mentioned otherwise, - all $$ are in AUD - profits mean profits before taxes	

2 Purpose of case study and audience

The team at CSIRO has developed a suite of microencapsulation technologies (1999-2019) with diverse applications in food, pharmaceutical, medical and plant industry. The purpose of this case study is to assess the benefits and impact generated through the development and commercialization of CSIRO's MicroMAX® 1, the first-generation microencapsulation technology developed. MicroMAX® 1 was licenced by Clover Corporation (Clover/CLV) in 2001 for microencapsulating and stabilizing sensitive nutritional oils (Docosahexaenoic acid (DHA)) for dry blending applications and presents the most successful commercial adoption case from this program.

MicroMAX® is a platform encapsulation technology for protecting sensitive bioactive components using robust films and/or matrices to preserve food, health and nutritional benefits. CSIRO's MicroMAX® provides the capability to protect sensitive bioactives from environmental degradation (improve shelf life) and reduce the development of off-flavours / off-odours. The technology offers a convenient format for delivery of bioactives and enhances bioavailability/controls release of key nutrients.

With health and wellbeing being one of the 6 major challenges that CSIRO is focused on, the study highlights the spectrum of economic, environmental and social benefits arising for a range of stakeholders from this work at the macro (government at three levels/ public), meso (CSIRO and collaborators like CLV/ Pharmamark/ NurtiV etc) and micro levels (researchers/ social scientists).

The analysis provides an estimate of the benefit-cost ratio and the direct, indirect and potential future benefits of this work. The case study also discusses the key limitations and foreseen challenges in the future uptake and adoption of this work.

This report can be read as a stand-alone item or alongside other CSIRO Agriculture and Food evaluations to substantiate the impact and value of CSIRO's activities against funds and resources invested in this program. CSIRO as a service provider to the Government and industry is highly focused on delivering value and impact through the scientific interventions that originate from research activities. The information is provided for accountability, communication, engagement, continuous improvement and future application purposes. The study is also intended to serve as a tool to underpin strategic investment decision making. The intended audience includes Business Unit Review Panels, federal, state and local governments, key investors, collaborators and licensors (Clover/ Pharmamark/ NurtiV/ CanPal/Nutrition Science Australia), CSIRO, universities and the general public.

3 Background

Transition from traditional to functional food

The primary role of the diet is to provide enough nutrients to meet the nutritional requirements of an individual. There is increasing scientific evidence to support the hypothesis that some food components have beneficial physiological and psychological effects over and above the provision of basic nutrients.[1] Nutrition science has moved on from the concepts of avoiding nutrient deficiencies and basic nutritional adequacy to the concept of "positive" or "optimal" nutrition. The research focus has shifted to the identification and protection of biologically active components in foods that have the potential to optimise physical and mental wellbeing while reducing the risk of diseases such as cardiovascular disease (CVD), cancer and osteoporosis [2]. New foods are being developed to incorporate these components for enhancing health benefits or desirable physiological

[1] European Commission Community Research (2000) Project Report: Functional food science in Europe, Volume 1; Functional food science in Europe, Volume 2; Scientific concepts of functional foods in Europe, Volume 3. EUR-18591, Office for Official Publications

[2] Augustin, M.A., and Sanguansri, L. (2007) Encapsulation of bioactives. In Food Materials Science - Principles and Practice (Lillford, P.J., and Aguilera, J.M., eds.), pp. 577-601, Springer, New York.

effects. Combined with a healthy lifestyle, functional foods can make a positive contribution to the health and wellbeing of the community.

Challenges in the production of functional foods

Instability (leading to short shelf life), sensory unacceptability and limited bioavailability present some of the challenges associated with the formulation and processing of some highly nutritious/ efficacious ingredients for food and pharmaceutical production. This limits their utilization into functional foods and leads to other issues associated with their handling and transportation.

CSIRO's Response: MicroMax® Technology

Box 1- CSIRO's MicroMAX®

CSIRO's MicroMAX® is an innovative platform technology for microencapsulation of bioactive nutrients to protect them from degradation during processing, storage and gastro-intestinal transit. It was revolutionary technology at the time of its initial invention in ~1999/2000 and has attracted sustained interest/growth over the years.

For more information, see: Understanding Microencapsulation in a min.

MicroMAX® is a protective technology that can be used to induce following benefits:

- Improved shelf life: Stabilises and protects bioactive nutrients that degrades rapidly once isolated from its natural food matrix or environment
- Maintain sensory acceptability: Masks off-flavours / off-odours (depending on application)
- Powder *vs* liquid delivery: Offers convenient format for delivery of bioactives
- Improved nutritional content: Allows incorporation of sensitive bioactives into foods and in the case of MicroMAX Veg additionally allows the delivery of a serve of vegetables.
- Enhances bioavailability of the microencapsulated nutrient: Maximises the absorption of nutrients for the consumer.
- Controlled release: Potential delivery to specific sites in the body

Due to the above attributes MicroMAX® is used in the food industry as an enabling technology for production of functional foods and delivering a range of tailored food ingredients with superior performance.

Success story: MicroMAX® 1 commercialization by Clover Corporation

Box 2 Clover Corporation Limited (CLV) – innovation opens a brand-new chapter of success for family business

Clover (CLV) is a niche food ingredients' company with core business activities in the production and sale of Docosahexaenoic acid (DHA; type of Omega 3 fat) rich micro-encapsulated powders. CLV utilises CSIRO's MicroMax® 1 technology under exclusive licence to microencapsulate and stabilize DHA oils for dry blending applications. These DHA powders are sold to many leading infant formula manufacturers in Australia, New Zealand and globally.

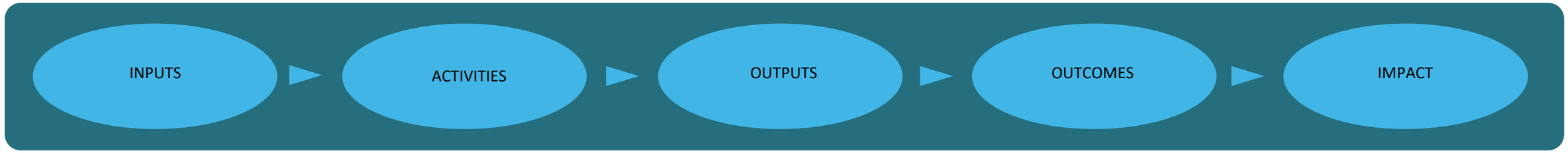
Early Years (1988 – 2007)
CLV was founded in 1988 as a family owned Australian company providing natural oils-based ingredients. It was listed on the ASX in Nov 1999. In 2002 CLV formed a JV company - Nu-Mega Ingredients Pty Ltd with Queensland based Food Spectrum Group, a manufacturer of functional food ingredients. This was owned 70% by CLV initially and moved to full ownership in 2007.

Current Scenario
CLV's subsidiary Nu-Mega, supplies Nu-MegaDriphorm® powders that utilise CSIRO's MicroMax® 1 technology as explained above. Driphorm® powders are used in a wide range of infant formula, follow-on formula, growing up milks and food applications, nutraceuticals, pharmaceuticals and sports nutrition markets. CLV utilizes the patented technology for the encapsulation of marine (fish) oils and algae oils into a dry stable powder form. This protects the ingredients from oxidation, degradation and adverse taste and smell. CLV is one of the only four global providers of these key ingredients

CLV signed important supply contracts for ingredients for infant formula ("IF") manufacturers with Heinz Farley in the UK (March 2002), International Nutritional Company of Denmark (INC; March 2003) and Mead Johnson USA (Bristol-Myers Squibb; Dec 2007). These were the "break-through" contracts which validated CLV's technology and quality and provided international credibility.

Strong 10-year track record
The performance of the company has been impressive since 2008, with revenue growing by an average of 11% CAGR, and normalised net profit after tax (NPAT) and earnings per share (EPS) growing by 15% pa. Also, the share price rose from 17.5 cents then to >$2.00 today

4 Impact Pathway



Funding

- CSIRO BU (A&F, H&B) funding and in-kind support
- CSIRO Preventative Health Flagship
- Food-Into-Asia
- External financial Investment by
  -key organizations like Clover, Pharmamark and NutriV
  -other companies who evaluated the technology over the years

Research Capabilities

- Background knowledge and expertise in microencapsulation technology (since 1996)
- Science and engineering disciples – Food chemistry, material science, colloid science, process engineering, food engineering, food product development
- Access to high calibre, multidisciplinary capabilities (CSIRO and industry partners incl Universities)
- Access to infrastructure and resources to execute projects (e.g. on-site and off-site facilities – laboratories - chemistry, physical testing, microscopy, microbiology, food sensory, food product development; pilot-scale food processing plant equipped with a range of equipment, computer resources etc)

Translational and Commercialization Support

- Internal CSIRO BD&C
- Strategic commercialization planning and execution by Industry partners

Funding

- CSIRO BU (A&F, H&B) funding and in-kind support
- CSIRO Preventative Health Flagship
- Food-Into-Asia
- External financial Investment by
  -key organizations like Clover, Pharmamark and NutriV
  -other companies who evaluated the technology over the years

RD&I

Research, PoC and IP development for

- MicroMAX®-1 through CSIRO Food into Asia Program & Clover Corporation Ltd (1999-2003)
- MicroMAX®-2 through CSIRO's P-Health Flagship (2003)
- MicroMAX®-Pro through CSIRO's P-Health Flagship (2004)
- MicroMAX®-PL (2013)
- MicroMAX Veg – (2018-2019) – No formal internal CSIRO project; Developed with staff goodwill and creative time

Collaboration with key players in food industry

Regulatory Approval activities

- Engagement with Health & Nutrition Science Division to assess the safety of the original MicroMAX®
- For original MicroMAX®, allowed ingredients for use in infant formula from approved ingredient listings for target applications

Translation and commercialization of developed technologies

- Original MicroMAX - P-Health Flagship and then FSA BD&C shared responsibility for commercialisation with science team
- For MicroMAX Veg, Ag&Food BD&C with science team

Licencing activities

Education and Outreach

- Technology Transfer Training (domestic and international)
- Masters, PhD and Post Doc training

New Technologies

- MicroMAX® 1 for Oxidation Stabilisation
- MicroMAX® 2 for GI Tract Delivery
- MicroMAX® Pro for Probiotics Encapsulation
- MicroMAX® PL for Krill Oil Encapsulation
- Functionalised Starch for Pre-processed RS
- MicroMAX® Veg for Vegetable Delivery System for Omega3
- MicroMAX Veg (Pro) & MicroMAX Veg (Omega-3 and Probiotics)
- New microencapsulated ingredients and products

External Network:

- Working networks and relationships between CSIRO, ingredient supplier and food product manufacturer
- Collaboration with >20 companies in different capacities (licencing, training etc)

Training Programs

- Domestic and international training programs
- Microencapsulation training workshops
- Industry technology transfer training

Patents, Publications and Awards

- Patents
- Publications
- Awards
- Case Studies

Postdoc recruitment

- CSIRO Post-docs

New Technologies

- MicroMAX® 1 for Oxidation Stabilisation
- MicroMAX® 2 for GI Tract Delivery
- MicroMAX® Pro for Probiotics Encapsulation
- MicroMAX® PL for Krill Oil Encapsulation
- Functionalised Starch for Pre-processed RS
- MicroMAX® Veg for Vegetable Delivery System for Omega3
- MicroMAX Veg (Pro) & MicroMAX Veg (Omega-3 and Probiotics)

Uptake and adoption

- Stabilization and delivery of sensitive bioactives
- Successful commercial adoption of technology for spectrum of health-promoting foods and beverages

Access to healthy nutritional supplements for the community (infant formula and food market)

New ways for inclusion of nutritional health supplements in foods and pharmaceutical industry

Revenue streams from the new products for industry
-Growth of Clover from a small family-based business
- Nu-Mega Driphorm powders being internationally recognised as the benchmark for quality and stability.
- Licensees of technology – Clover, Pharmamark, CannPal, NutriV

Cost savings from longer shelf life items

Engagement and Capability Building with >20 organizations

ECONOMIC IMPACT

- National Economic Performance: Export revenue and domestic demand from products based on MicroMAX® 1 technology. Improved business profitability (value-added)
- Trade and competitiveness: Expanded export and domestic demand in functional foods
- New services, products, jobs and market niches enabled by new technologies.
- Improved production processing efficiency and productivity
- International reputation of Australia in this space

ENVIRONMENTAL IMPACT

- Lower environmental footprint of food production due to lesser food wastage from longer shelf life of food items

SOCIAL IMPACT

- Health and wellbeing of community through access to high nutritional value food products
- Better quality of life through better health
- Innovation and human capital through application of these new technologies in new industries

FY1999-FY2005

FY2005-2015 to FY2027

Figure 1: Impact Pathway for CSIRO's MicroMAX® Development

3 Impact Evaluation

Program inputs

The Microencapsulation research has been ongoing since 1996, initially separately in CSIRO and Australian Food Industry Science Centre (AFISC) and then as part of Food Science Australia initiative (a joint venture between part of CSIRO and AFISC) and later the broader CSIRO initiative known as Ingredient Functionality Research and the P-Health Research Flagship. There is no program related information available for 1996-1999 and hence the assessment has been conducted post FY1999.

CSIRO's inputs

- CSIRO Funding: $7.9 million; For more details see Table 1
- > 20 years of background knowledge and expertise in this space
- Access to high calibre, multidisciplinary CSIRO capability
- Access to infrastructure and resources to execute projects (e.g. on-site and off-site facilities – laboratories - chemistry, physical testing, microscopy, microbiology, food sensory, food product development; pilot-scale food processing plant equipped with a range of equipment, computer resources etc)
- CSIRO's brand recognition, strategic position and existing relationships that enabled successful uptake, adoption and further development of technology.

Partner inputs: CSIRO has collaborated and engaged with >20 companies for this work. The complete list is included in Appendix A. Partner inputs include:

- External Funding: $16.7 million by > 20 companies. Main collaborators: Clover Corp, Pharmamark
- Strategic commercialization planning and execution

It is estimated that $ 24.6 million (nominal, undiscounted) has been invested into Microencapsulation research program.

Table 2: Investment to date in MicroMAX® technology development

FUNDING SOURCE	YEAR(S)	AMOUNT	PERCENTAGE	COMMENTS
FSA/CSIRO*	1999-2019	$ 7.9 million	32%	CSIRO A&F, A&F predecessor BU's, P-Health flagship, Health and Biosecurity (H&B) and its predecessor BU
External	1999-2019	$16.7 million	68%	CLV, Pharmamark, CannPal
Total	1999-2019	$24.6 million	100%	

SOURCE: CSIRO

*No investment (internal or external) has gone into this work in the last 7 years (since 2013)

Timeline for evaluation
Costs: FY1999- FY2013
Benefits: Ex-post: FY2006 to FY2019
Ex-ante: FY 2020 to FY2027

Activities

This investment has enabled various activities for research and development of a suite of MicroMAX® technologies that include:

i. MicroMAX® 1 through CSIRO Food into Asia Program & Clover Corporation Ltd (1999-2003)
ii. MicroMAX® 2 through CSIRO's P-Health Flagship (2003)
iii. MicroMAX® Pro through CSIRO's P-Health Flagship (2004)

iv. MicroMAX® PL (2013)

v. MicroMAX Veg (2018/2019) – In-kind contribution of staff time only

See Appendix B for information on the suite of MicroMAX technologies developed by the team.

The CSIRO team has been actively involved in translational, licensing and commercialization activities to further advance development and uptake of technology. In addition, training (technology transfer), education and outreach also form important activities of the program.

As mentioned before, the focus of impact assessment for this study is MicroMAX® 1. The translation and commercialization of MicroMAX® 1 started in collaboration with Clover Corporation Ltd (CLV). Due to industry engagement from the beginning, the R&D project was strongly aligned to the needs of partners and consumers.

Outputs

The fundamental output of focus in this assessment is MicroMAX® 1, an innovative "technology platform" for the protection and delivery of bioactives through functional foods while using:

- natural food-grade materials without additives
- simple chemistries
- flexible formulation and product format
- standard food processing equipment

Publications and Awards

- Australian AIFST Award (2002)
- AOCS Corporate Achievement Award (2004)
- Important publications covered in Appendix B

Outcomes

MicroMAX® technology provided an innovative solution for the stabilisation and delivery of sensitive but efficacious bioactives. The market saw early uptake of technology for the application of bioactives across a spectrum of health-promoting foods and beverages for the modern consumer.

See Appendix B for a) potential commercial use cases of the suite of advanced MicroMAX® technologies (IP) developed by the team and b) current and potential future clients.

Commercial adoption of MicroMAX® 1

As mentioned, utilization MicroMAX®1 by CLV for encapsulation of omega-3 oils (See Box 2) presents the most successful commercial adoption case from this program. Figure 2 highlights some examples of uptake of DHA powders for market products in period of 1998-2008.

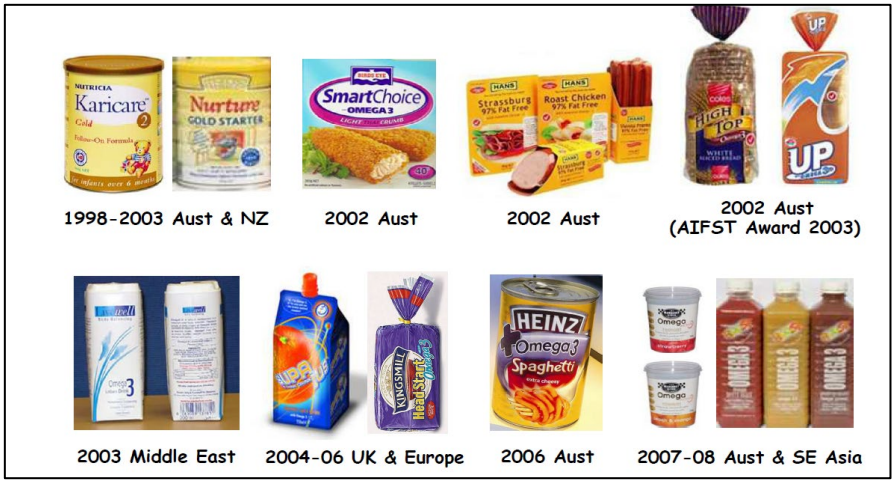


Figure 2: Products from market adoption of MicroMAX® based DHA powders

Also see Section 7 for potential future outcomes.

Impacts

Table 3: Summary of project impacts using CSIRO triple bottom line (TBL) benefit classification approach

Type	Category	Indicator	Description
Economic	National Economic Performance Trade and competitiveness New Services, products, experiences, jobs and market niches Productivity and Efficiency	- Export revenue and domestic demand from products based on MicroMAX® technology - Revenue from the sale of new product streams - Premium earned from higher quality and longer shelf life products - Cost savings (better health) induced by access to higher nutritional value health products - Cost savings, higher productivity and efficiency enabled by technology and healthier workforce (↓ sick time)	- adoption of MicroMAX® encapsulated bioactive ingredients in a range of food products for Australia's export market - expanded export and domestic demand in terms of increases through improvements in the quality and features of functional food; - new products in market with increased processing productivity through less capital and labour used per unit of output; - improved health outcomes for consumers through access to nutritional health supplements - improved economic-wide impacts for regions such as business profitability, household income and employment impacts; and - strategic relationships with other state departments and commercial partners leading to new business opportunities and products
	International reputation of Australia in this space	↑utilization of DHA in infant formulas ↑demand of Clover products based on MicroMAX-1	- Increased utilization of products that emerge from implementation of the suite of microencapsulation technologies
Environmental	Lower environmental footprint of food production	Lower proportion of waste generated by low shelf life products (Primarily applicable to MicroMAX Veg)	- Improved shelf life enabled by MicroMAX® technology through stabilisation and protection of bioactive nutrients leads to lower waste products
Social	Health and wellbeing Better quality of life	- better overall health - lower losses (incl but not limited to): productivity, carer costs, dead weight loss (DWL) etc	- lower financial and non-financial costs to the health system - New income streams and wellbeing enabled by application of technology to new sectors
	Innovation and human capital	- New applications of the technology in other sectors	

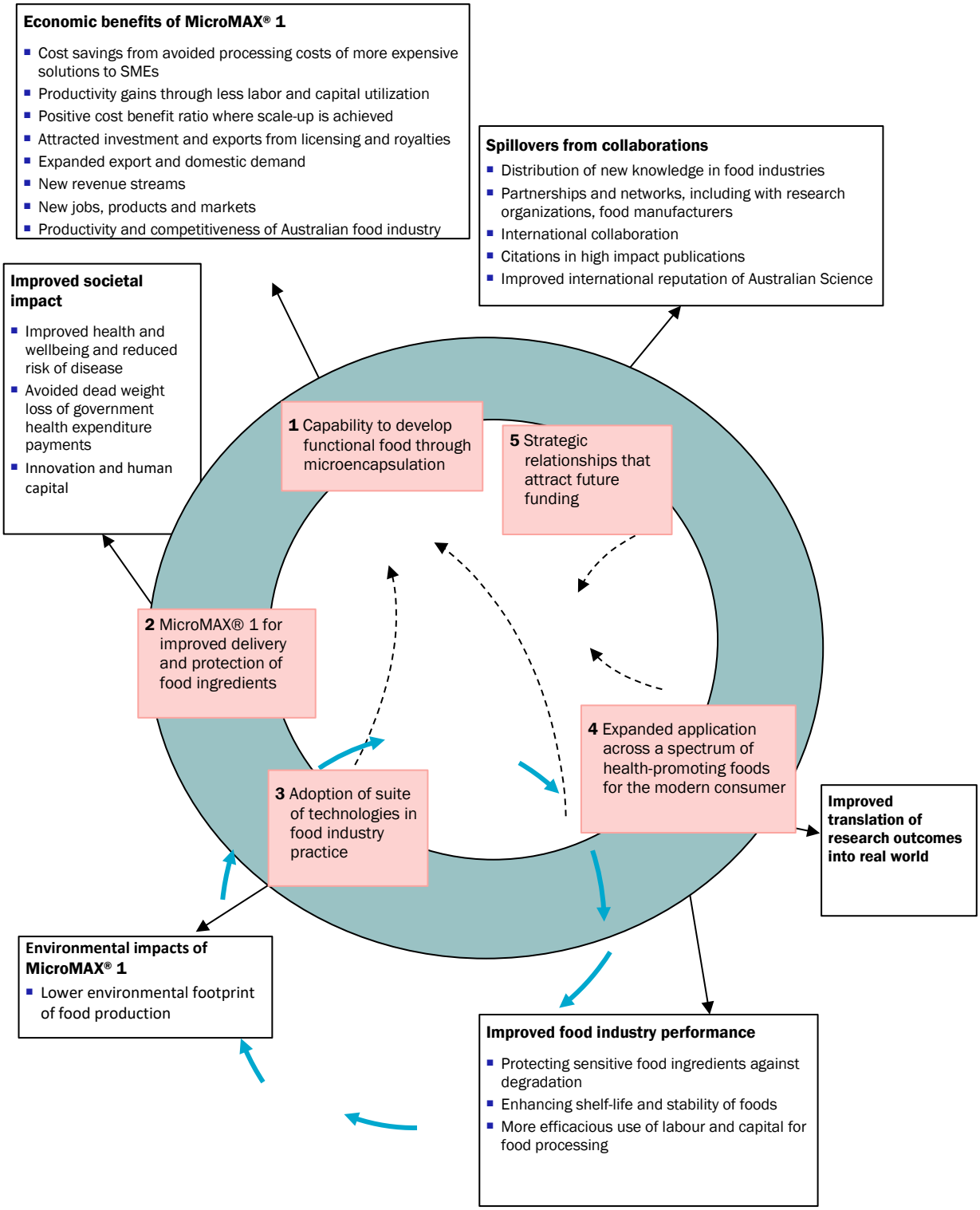


Figure 3: Key outcomes (circle – inner boxes) /impacts (circle-outer boxes) of MicroMAX® 1 technology platform

Source: CSIRO

5 Economic Modelling and Results

Cost Benefit Analysis

The economic assessment for this study focuses on the commercial adoption of MicroMAX® 1 by Clover Corporation. CLV utilizes this technology to microencapsulate nutritional oils (see Box 2). MicroMAX® 1 stabilizes the sensitive Omega 3 oils in DHA powders which can then be dry blended into a variety of foods, infant formulas and pharmaceutical products[3]. The patented technology allows up to a 50% oil loading (double with respect to (wrt) market comparables), oils can be cooked, have no smell or taste and have extended shelf life compared to other competitive products in the market

This section provides an indication of MicroMAX® 1's realised and potential future impacts through assessing **producer surplus from the sale of DHA powders by Clover.** The author has taken a producer surplus[4] approach as other potential approaches (consumer surplus) are not possible due to lack of underpinning data. This will become clearer in subsequent sections.

Perspective and stakeholders

Given the global nature of the industry, the footprint of benefits is not limited to Australia but realised globally. However, for most CSIRO research, the quantification of benefits is kept limited to the national level.
In general, as the impact assessment needs to be conducted from Australia's perspective, it includes economic costs and benefits arising from CSIRO as well as other potential stakeholders of this project which include (but not limited to):

- Food processors, retailers and other players in the supply chain;
- Consumers and the broad community; and
- Governments

CBA cases

Cost benefit analysis has been conducted for the period 1999 to 2027 and estimates the short, medium and long-run effects of CSIRO's MicroMAX® 1 technology platform on the Australian economy and community. This analysis determines:

- A base case (status quo) i.e. a benchmark to compare counterfactual scenario representing the possible outcome in the absence of introduction of MicroMAX® 1, and
- The project case that estimates producer surplus benefits from demand and sale of DHA powders by CLV that are manufactured using MicroMAX® 1 technology.

Base Case (counterfactual)– without MicroMAX® 1 scenario

The counterfactual would represent a situation where CLV would not have unique competitive advantage imparted by the utilization of MicroMAX® 1 in the manufacturing of DHA powders. This includes:

i. stabilized sensitive DHA oils in powdered form that impart double oil loading compared to competitive products (↑cost-effectiveness)
ii. strong antioxidative properties of DHA powders which allows them to be stored and transported under ambient conditions and have a minimum shelf life of two years (competing products in the market have only 1-1.5 year shelf life)
iii. superior odour and taste masking of CLV's encapsulated omega-3 powders (DHA), a significant advantage compared to competitive products

[3] https://www.clovercorp.com.au/en/discover-our-products/dha-powders/#:~:text=Clover%20%2D%20DHA%20Powders&text=Nu%2DMegaDriphorm%C2%AE%20powders%20utilise,superior%20odour%20and%20taste%20masking.

[4] Explained in "Approaches for conducting CBA" section below

iv. consumer access to nutritional products with enhanced health benefits through the application of MicroMAX® 1

Access to a similar technology for production of DHA powders would be delayed by at least 10 years in the absence of CSIRO's work. This timeframe is an arbitrary estimate however supported by the fact that even after many years since commercialization, this technology still has a competitive advantage over other similar commercial options available in the market[5].

Time period and Costs

CSIRO's microencapsulation research is an ongoing activity. For the purpose of this assessment, the analysis is based on research activity since 1999. For details on Costs and Timeline of the program See Inputs section.

Timeline	Costs: FY1999- FY2013 Benefits: Ex-post: FY2006 to FY2019 Ex-ante: FY 2020 to FY2027 (MicroMAX® 1 is licenced by CLV until 2027)
Costs	**R&D Costs**: CSIRO made an in-kind co-contribution of $7.9 million (nominal) towards the total project budget of $24.6 million (nominal) between 1999 and 2013. No investment has gone into this work since 2013.

A conservative approach is adopted where it is assumed that benefits are measured to 2027. This is consistent with our assumption that in the counterfactual scenario the development and adoption of the technology would be delayed by at least 10 years. Also, Clover holds its licence for MicroMAX® 1 from CSIRO until 2027. Thus, the analysis involves a component of *ex-post* analysis (relating to the costs and benefit in the period 1999 to 2019), but also a large component of *ex-ante* analysis forecasting the benefits flowing from the research activities over the period 2020 to 2027.

Attribution

The research work of the program was undertaken by CSIRO. CLV collaborated in the project from the beginning, which resulted in R&D being aligned to the intended commercial outcomes of the program.

Based on the R&D cost sharing approach, of the total $24.6 million total investment this case study will attribute total benefits as follows:

- CSIRO – 32% (contribution: $7.9 million)
- Industry funders especially CLV and Pharmamark – 68% (contribution: $16.7 million))

Other inputs (such as business development, marketing) were key elements for successful path to market execution. However, the associated costs have not been incorporated for this analysis.

Approaches for conducting CBA

In the absence of any identified externalities, the economic benefit of MicroMAX® 1 technology can be estimated essentially from one of two perspectives:

- A **"consumer surplus"** approach that estimates the additional willingness to pay for products manufactured using MicroMAX® 1 technology, which could be based on any increase in price paid by buyers
- A **"producer surplus"** approach could be employed by estimating the additional profit reaped by the manufacturer of MicroMAX® 1 -imbued products.

Application of conventional **"producer surplus"** approach in this case would be to estimate the additional revenue (Price * Quantity) gained by a manufacturer at the wholesale level for the DHA powders. This approach reflects the additional value gained by a middleman buyer and their willingness to pay for it. The advantage of choosing the wholesale price level is that any change in price or quantity is not confounded by other factors, such as packaging or brand loyalty

[5] https://stockhead.com.au/health/why-clover-corp-is-outperforming-its-bigger-infant-formula-rivals/

associated with the final product; infant formulas at the retail level in this case. However, the information required for this approach is not readily available for this analysis and would normally be treated as commercially sensitive.

MicroMAX® 1 technology-based DHA powders used in infant formulas have double oil loading and shelf life compared to competitive products in the market[6]. This equates to cost-effectiveness and reduced wastage. An initial assumption could be made that a doubling of oil loading, for the same amount of powder would increase (possibly even double) the price that infant formula manufacturers are willing to pay to a supplier of the products. However, information such as the price premium received by a supplier from the sale of MicroMAX® 1 based DHA powder is commercially sensitive and unavailable for this assessment, as explained above.

Similarly, due to increased shelf life consumers could be considered to have a higher willingness to pay for infant formula produced with MicroMAX® 1 powder compared to "similar" products in the market. However, this approach of estimation is likely to result in complications whose resolution requires detailed market information. For example, baby formula with a shelf life that has been increased to six months may hold no advantage for a buyer if the packet of baby formula is typically consumed within one month. Brand loyalty, marketing, and perceived health benefits could also affect the buyer's willingness to pay, irrespective of increased shelf life.

In the absence of relevant information and detailed data for the approaches outlined above, a third, "producer surplus", approach was adopted for conducting this CBA by estimating the additional profit made by Clover Corporation. The "before tax profit" is used because it represents the additional net economic value generated. Tax levied is just a transfer to government of a portion of the value generated. See section below for further details.

Quantifying Benefits – Producer Surplus approach

The CBA is conducted through estimation of benefits from demand and sale of MicroMAX® 1 technology based DHA powders as measured by the overall profits -realised (ex-post) and forecasted (ex-ante) for Clover.

Clover being a publicly traded company, the financial data available in public domain has been used for assessment of economic benefits attained from sales of DHA for the evaluation period.

Overall benefits = $(P_{R1}+ P_{R2})$ Ex-post period **+** (P_{R3}) Ex-ante period	
$P_{R1}+ P_{R2}$	Clover's Profits before tax Ex-post period
P_{R3}	Clover's Profits before tax Ex-ante period Note: We consider Profit before tax as tax is just a transfer to the government of part of the additional production that the firm (CLV) has generated. It is the value of the additional demand due to technological innovation that is the social benefit; which we are trying to assess here. The reported profits also disregard the depreciation and amortisation, as these are non-cash expenses spread over several years.
$P_{DHA\ powder}$	Clover's Profit from sale of DHA powder Note: This information is sensitive and not available. CLV's revenue share from DHA powder has been reported as 70%[8]. For the purpose of this assessment profit share is assumed to be same as revenue share.

[6] https://www.asx.com.au/documents/products/clv-191001-phillipcapital-fy19-results.pdf

Table 4: Economic benefits assessment (B1): Clover earnings from MicroMAX® 1 based DHA powder

MEASURE		VALUE	SOURCE
Clover's (ASX: CLV) Profits before tax (DHA based on CSIRO's MicroMAX® 1 technology is company's key product)			
P_{R1} (2000-2009)	CLV Profits before tax in the period of FY2000 – FY2009 (in mil, FY2019 $$)	-	Data Unavailable, not considered for assessment
P_{R2} (2010-2019)	CLV Profits before tax in the period of FY2010 – FY2019 (in mil, FY2019 $$)	88	CLV's financial Statements, See Appendix C for complete data (profit before tax)
P_{R3} (2020-2027)	CLV Profits before tax in the period of FY2020 – FY2027 (in mil, FY2019 $$) Projected: - 15% ↑ in profits for FY2020-FY2021 - 10% ↑ in profits for FY2022-FY2024 - 5% ↑ in profits for FY2025-FY2027	137	↑ in profits projected based on booming market, past performance from 5 years and regulatory changes in EU. We use different profit estimates for different years as profits are by nature hard to forecast. Sovereign and exchange risks significantly affect CLV's profits and by 2027 there is likelihood of competition taking over the market
P_o	CLV Overall Profits FY 2000-2027 (in mil, FY2019 $$)	225	$P_{R1} + P_{R2} + P_{R3}$
R_o	Overall revenue share of DHA for Clover; this is assumed as overall profit share as well due to absence of this data[7]	70%	Reference - Livewire Report
Benefit (B1)	Indicative share of DHA profits for Clover (in mil, FY2019 $$)	158	Assumption: Clover's Profit before tax share from sale of DHA powder is same as revenue share of DHA powder

Project Assumptions

1. **Adoption costs of technology**: For simplicity of CBA it is assumed that the adoption cost for CSIRO's MicroMAX® 1 is comparable to other competitive encapsulation technologies available in Australia.
2. Due to lack of data it is assumed that profits will mirror revenue thereby implying constant costs.
3. Clover's Profit before tax share from sale of DHA powder is assumed to be the same as revenue share of DHA powder as underlying data is unavailable
4. Projected 15% increase in revenue every year supported by booming market and past performance from 5 years[8]
5. Real Discount rate of 7 per cent, based on CSIRO. Feb 2020, 'Impact Evaluation Guide', p. 13.

Market data that underpins projected ex-ante profits (2020-2027)

Clover's exposure to the China-led boom in infant formula market and recent European regulations that mandate increased minimum levels of its encapsulated form of tuna oil containing DHA is positioning the company for further success and profits from the sale of its core product.

The USA Food & Drug Administration has recently announced a qualified health claim linking EPA and DHA Omega 3's to a reduction in blood pressure allowing products that incorporate 0.8 grams per serving to be labelled "Consuming EPA and DHA combined may reduce the risk of CHD (Coronary Heart Disease) by lowering blood pressure". This is a step forward in the formal recognition of the benefits of Omega 3 which have been proven by clinical trials and expected to spur the introduction of additional products targeted at helping people suffering hypertension[8].

The combined result of new products, additional staff and the synergies between technical and business development staff is expected to drive expanded sales for Clover.

[7] **https://www.livewiremarkets.com/wires/the-new-criterion-the-real-stock-tapping-the-infant-formula-boom**

[8] https://www.marketscreener.com/CLOVER-CORPORATION-LIMITE-6492275/news/Clover-Delivers-Record-Revenue-and-Profit-Growth-for-2019-29232313/

In addition, the new licensed facilities and continued dairy investment in Australia and New Zealand provide Clover with opportunities to diversify its customer base and increase demand from China[9].

Results

As stated above, the key economic benefits assessed for this impact evaluation include:

- Commercial gains to Clover from the demand of their niche product - microencapsulated DHA powders based on CSIRO's MicroMAX® 1 technology which forms an important ingredient for infant formulas manufactured globally.

To estimate the return from the overall investment in the development of MicroMAX® 1 technology (including both external and CSIRO internal resources), it is assumed that all benefits to the Australian community are relevant, as this would be the measure of interest to the nation. On this basis, the Net Present Value (NPV) and benefit cost ratio (BCR)/return on investment ratio (ROI) for Australia is calculated as below:

- NPV of $110 mil (2019$$) over a period of FY2010-FY2027 from demand and sale of DHA powder globally with a BCR of 3.3 (or ROI; actual period for analysis is 2006-2027; however, there is no data available for assessment for the period of 2006-2009 (incl))

Table 5: MicroMAX® 1 case-study CBA results. Basis: overall investment costs (all $$ in mil, 2019)

Table Scenario	PV costs	PV benefits	NPV	BCR
Higher demand and sale of MicroMAX® 1 based DHA powder manufactured by Clover	48.4	158	110	3.3
Improved business performance and reputation		Not quantified		

Note: Real Discount rate of 7 per cent per annum, based on CSIRO. Feb 2020, 'Impact Evaluation Guide', p. 13. *SOURCE: CSIRO.*

To estimate the return on CSIRO's financial contribution to the MicroMAX® 1 technology, it is assumed that CSIRO's share of total costs is a suitable proxy for its share of attributable benefits. On this basis, the NPV and BCR/ROI for Australia is calculated as below:

- NPV (CSIRO): $35.1 million AUD over 1999-2027 due to increased uptake of CSIRO-enabled MicroMAX® 1 technology with a benefit-cost ratio of 3.3

Table 6: Key MicroMAX® 1 case-study CBA results. Basis: CSIRO investment (all $$ in mil, 2019)

Table Scenario	PV costs	PV benefits	NPV	BCR
Higher demand and sale of MicroMAX® 1 based DHA powder manufactured by Clover	15.5	50.7	35.1	3.3
Improved business performance and reputation		Not quantified		

Note: Real Discount rate of 7 per cent per annum, based on CSIRO. Feb 2020, 'Impact Evaluation Guide', p. 13. SOURCE: CSIRO.

Sensitivity Analysis

Sensitivity analysis has been conducted to account for the inherent risks and gauge the effect of deviation in the parameters presumed for the analysis. The CBA is necessarily based on a series of assumptions which implies that there is a degree of uncertainty around the results; some of which include:

i. Real Discount rate: This is a significant parameter that affects the overall reported economic impacts. To improve the robustness of CBA and ensure the discount rate is appropriate and not solely responsible for the reported impacts, sensitivity analysis is performed with varying real discount rates.

[9] Note: COVID-19 might have some affect on these claims in the short-medium timeframe.

ii. Ex-ante benefits (FY2020 – FY2027)**:** The ex-ante analysis in Table 4 is based on substantial assumptions. Future profits are by nature hard to predict due to the uncertainty associated with market conditions, especially factors like changing geo-political dynamics due to COVID-19. Sovereign and exchange risks can affect Clover significantly in the post-COVID world, as:

- Sovereign risk: Significant particularly wrt China. Due to changing geo-political environment and protecting Chinese manufacturers. Non-tariff barriers like permits can easily stop exports. Barley and beef are recent examples.
- Exchange rate risk. Unless Clover hedges exchange rate risk, earnings could fluctuate very significantly in the post-COVID-19 world.
- Also, CSIRO's patent is near its life. It is not easy to implement the published patent by any future licensees without the support or know-how that the CSIRO team has acquired in the last >20 years.

To address the above issues, sensitivity analysis (See Table 7) is performed with varying CLV profit estimates for ex-ante period.

Table 7: Sensitivity analysis (all $$ in mil, 2019)

VARIABLES	NPV	BCR
No Changes (assumed 7%)	110	3.3
Real Discount @ 4%	116	3.4
Real Discount @ 10%	121	3.2
↑Clover's Projected Profits for 2020-2027 (ex-ante period)		
VARIABLES	**NPV**	**BCR**
No change (Projected Profits ex-ante period - 15% ↑ in profits for FY2020-FY2021 - 10% ↑ in profits for FY2022-FY2024 - 5% ↑ in profits for FY2025-FY2027)	110	3.3
↑Projected Profits 5% (ex-ante period - 30% ↑ in profits for FY2020-FY2021 - 20% ↑ in profits for FY2022-FY2024 - 10% ↑ in profits for FY2025-FY2027)	163	4.4
↑Projected Profits 20% (ex-ante period - 7.5% ↑ in profits for FY2020-FY2021 - 5% ↑ in profits for FY2022-FY2024 - 2.5% ↑ in profits for FY2025-FY2027)	90	2.9

From the results, it is evident that variation in Clover profits will have the most significant effect on the NPV, while a decrease in the real discount rate would improve the net benefits. The sensitivity analysis is just intended to highlight variation of NPV and BCR wrt variables (profits before taxes and real discount rate in this case).

7 Potential future commercial applications

Hemp and cannabis-based animal health products

As per a recent announcement (Jan 2020) CannPal Animal Therapeutics Limited (ASX:CP1) has entered into an exclusive licencing agreement with CSIRO to commercialise patented MicroMAX® 1 microencapsulation technology for use in the field of animal therapeutics. The 18-month evaluation demonstrates that the technology can successfully encapsulate CannPal's oil formulations with superior protection capabilities and substantial improvement in oxidative stability,

enabling CannPal to add hemp and cannabis oils to a wider range of innovative new product applications for companion animals.

Encapsulation of probiotics using MicroMAX®-Veg

MicroMAX® Veg (2018/2019), the most recent plant-based encapsulation technology has recently been the basis of the formation of a new company NutriV – where CSIRO is a co-investor. The technology is being explored to protect the viability of probiotic bacteria during processing, storage and gastrointestinal passage.

8 Secondary impacts

This section summarises other non-quantified flow-on impacts, along with evidence of the extent to which they have been realised to date.

This information emerged from the workshop discussion with relevant CSIRO researchers on the ex-post impacts generated by MicroMAX® 1 technology.

Increased participation and productivity of workforce

Adverse health impacts not only generate direct financial costs to the health system and non-financial costs of the burden of diseases but a range of additional costs to the Australian economy.

In this case study, increased workforce productivity and participation are flow-on effects from MicroMAX® 1 powder consumption in reducing the prevalence of diseases in infants. For instance, parents with a healthier baby are more productive and spend less time out of work.

First mover benefits for MicroMAX® 1 technology-based ingredient and infant formula manufacturers

Clover Corporation, Danone Nutricia, Bellamy's Organic and other ingredient and infant formula manufacturers, may have experienced first-mover gains in the form of brand recognition, financial and customer loyalty benefits. Clover Corporation was the first manufacturing company engaged in the research collaboration with CSIRO to have the access to MicroMAX® 1 technology platform and market any products from it. More generally, any major provider currently engaged with CSIRO could have similar benefits from bringing an innovative product to the market first. In economic terms, it could be measured as increased sales through value-added products wrt competitive products in food manufacturing business.

9 Limitations

For our analysis, we have relied on CSIRO's funding data and other estimates based on inputs from external organizations and calculated assumptions. The data underpinning the analysis is acquired from domestic and international sources. As such, our analysis is limited by the constraints and uncertainties within this information. Some of the most significant risks and issues affecting the impact estimates include variations to the assumptions around:

i. The benefits have been estimated based on overall profits to CLV from demand and sale of MicroMAX® 1 based DHA powder. The technology was adopted in 2001 however there is no data available for period before 2010 for the purposes of this assessment; hence there is inherent deficiency in the reported results.
ii. The overall investment of $24.6 million AUD has been utilized to develop a suite of technologies. The reported benefits are only accounted from original MicroMAX® 1. With the recent licence acquired by CannPal, active engagement with industry for commercialisation of MicroMAX®-Pro (any further information is confidential at this stage); there is likelihood of more benefits emerging out of this work in coming years. Hence the reported benefits until FY2027 are very likely an underestimate.
iii. We had attempted to assess benefits from consumer surplus approach. However, due to unavailability of reliable data, this was not pursued.

To account for these limitations, where possible, any assumptions have been based on scientific and/or economic literature. However, in some cases, limited information exists for reference. These cases have been subject to sensitivity analysis and/or discretion explicitly advised in the report.

10 Confidence Rating

Data that underpins the CBA is based on information from last 20 years. Due to longer-term time frame some of it is inherently unreliable. The analysis is performed using CSIRO internal information (1999-2018), inputs from external organizations and calculated assumptions thereby making results approximation. CLV's profit data is unavailable for period of 2006-2009. Due to scope, financial and time constraints, further refinement of these estimates is not viable.

The author determines the confidence rating of this assessment as low-medium.

Appendix A References

https://www.livewiremarkets.com/wires/the-new-criterion-the-real-stock-tapping-the-infant-formula-boom

https://www.fool.com.au/2019/04/04/can-the-clover-corporation-share-price-continue-pushing-all-time-highs/

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https://www.verywellmind.com/the-health-benefits-of-dha-89183

Appendix B Key technologies developed by the team (other than MicroMAX® 1)

Table 8: Key technologies developed by the team, features, commercial uptake and active/ potential clients

Technology	Features	Commercial uptake	Active Clients and potential new licencees
MicroMAX® 2 GI Tract Delivery *TW7489/WO 2005/048998*	Tailored release and delivery in the GI tract, with pre-treated resistant starch	For medical and preventative health foods formulation – for delivery of bioactives in the GI tract	
MicroMAX® Pro Probiotics Encapsulation *TW7462/WO 2005/030229*	Superior probiotic protection under non-refrigerated storage and in acidic pH	For shelf stable powders, functional foods and beverage containing probiotics.	- NutriV: Veg-Omega3 Powders; Interest in probiotics (MicroMAX-Pro License) - Nutrition Science Australia: Interest in MicroMAX-Pro license
MicroMAX® PL Krill Oil Encapsulation *TW8721/WO 2014/169315*	Superior stability during storage and during high temperature & high process	Stable krill oil powders and emulsions for functional foods and supplement applications	
Functionalised Starch Pre-processed RS *TW7558/WO 2005/105851*	Resistant starch encapsulant, emulsion stabiliser, thickener, fat replacer, gelling agent, edible film	For *"low fat–fibre enriched"* yoghurt, ice cream, gelled dessert, spreads, sauces and beverage (smooth texture as control)	
MicroMAX® Veg Vegetable Delivery System *TW9291/WO 1/02/2019 PCT*	Vegetable based delivery system for omega3 & other bioactives with superior stability	Stable omega-3 vegetable powders plus other bioactives for food, feed and nutritional supplements	
MicroMAX® VegPro Probiotic & Gut health *TW9622/PROV*		Vegetable based delivery system for probiotics; increased Short chain fatty acid and healthy microbiota in the gut (in vitro)	

Appendix C Patents and Publications

1. Omega-3 oils Publications

Technology

i) Augustin, M.A., Sanguansri, L. and Bode, O. (2006) Maillard Reaction Products as Encapsulants for Fish Oil Powders. Journal of Food Science 71: E25-E32 – First paper

Clinical Trials

ii) Augustin MA, Sanguansri L, Rusli JK, Shen Z, Cheng LJ, Keogh J and Clifton P. (2014) Digestion of microencapsulated oil powders: In vitro lipolysis and In vivo absorption from a food matrix. Food & Function 11, 2905-2912

iii) Sanguansri L, Shen Z, Weerakkody R, Barnes M, Lockett T and Augustin MA (2013). Omega-3 Fatty Acids in Ileal Effluent After Consuming Different Foods Containing Microencapsulated Fish Oil Powder - An Ileostomy Study. Food & Function **4**, 74-82.

2. Co-delivery of Bioactives

iv) Augustin, M.A.., Abeywardena, M.Y., Patten, G., Head, R., Lockett, A., De Luca, A., and Sanguansri, L. (2011) Effects of microencapsulation on the gastrointestinal transit and tissue distribution of a bioactive mixture of fish oil, tributyrin and resveratrol. Journal of Functional Foods 3(1), 25-37

3. Probiotics

Technology

v) Crittenden, C., Weerakkody,R., Sanguansri, L. and Augustin, M.A.. (2006) Synbiotic microcapsules that enhance microbial viability during nonrefrigerated storage and gastrointestinal transit. Journal of Applied Environmental. Microbiology. 72(3), 2280-2282

4. Clinical Trial

vi) Pereira-Caro G, Oliver CM, Weerakkody R, Singh T, Conlon M, Borges G, Sanguansri L, Lockett T, Roberts SA, Crozier A, Augustin MA (2015) Impact of Probiotics on Gut Microflora and the Metabolism of Orange Juice Flavonoids. Free Radical Biology and Medicine 84, 206-214

Appendix D Clover Financials FY2010 to FY2019

Clover Profit Loss 2010-2019.xlsx