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| BANANAWAX  An ON program CASE STUDY | 1 |
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| Box  1 BANANAWAX Case Study - Executive summary |
| Key findings  The BananaWax research team has developed a technology to extract high value wax from the leaves of banana plants.  Banana wax is a more ecologically friendly alternative to Carnauba wax, which is currently the most common natural wax. It is obtained from the Carnauba tree in northern Brazil.  Banana wax can provide a local alternative to imported industrial waxes. It could allow banana farmers to develop a secondary business to generate auxiliary income and stimulate the local economy. In addition, the technology utilises what is otherwise a waste material which will have a positive impact on the environment.  Role played by CSIRO ON  The ON program helped the BananaWax team to: gain a better understanding of the problems and solutions regarding banana tree waste; better understand farmers’ priorities; and identify the key potential markets for the wax. Importantly, it also allowed the researchers to meet key stakeholders – including the owner of a local Queensland car care company who is going to trial the use of banana wax in his company’s car polish. |
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This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework to the BananaWax case study are summarised in Figure 1.

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| Figure 1.1 BANANAWAX Case Study – Impact Framework Diagram |
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| **INPUTS** |  | **ACTIVITIES** |  | **OUTPUTS** |  | **OUTCOMES** |  | **IMPACTS** |
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| * $50,000 in seed funding from QUT * At least $28,430 from in-kind support * Banana waste from farmers |  | * R&D into the extraction of wax from banana waste * Discussions with banana farmers * Discussions with Southern Cross University to undertake larger scale extraction of wax from banana waste |  | * Extraction of banana wax from banana farm waste * Better understanding of banana farmers’ priorities * Better understanding of potential market for BananaWax |  | * Demonstration of the proof of concept for extracting banana wax. * Agreement to trial BananaWax in car wax |  | * Identification of a potential source of additional income for banana growers * Potential environmental benefits from a reduced waste stream   A more environmentally friendly source of wax to potentially supply to the domestic market and for export. |

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| Source: ACIL ALLEN |
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## Purpose and audience for case study

This case study describes the economic, environmental and social benefits arising from the BananaWax project.

This evaluation is being undertaken to assess the positive impacts arising from the BananaWax project’s participation in the CSIRO’s ON. This case study can be read as a standalone document or aggregated with other case studies to substantiate the impact and value of the CSIRO ON activities as a whole, relative to the funds invested in these activities.

The information in this case study is provided for accountability, communication and continual improvement purposes. Audiences for this report may include Members of Parliament, Government Departments, ON, CSIRO and the general public.

### CSIRO ON

CSIRO ON was established in 2015 by CSIRO to help accelerate the impact of science research into market. The initiative was expanded through funding from NISA to service more broadly Australia’s publicly funded researchers and their industry partners. The aim of the initiative is to more quickly translate great science and technology research into positive impact to help address some of the economic, environmental and social challenges facing the Australian and global community.

There are a number of elements to the program, including two facilitated programs, ON Prime and ON Accelerate. These two elements are designed to complement each other.

ON Prime is an open and collaborative program for existing science projects as well as new technologies and projects that are still in development. ON Prime helps research teams to ensure that they are working on the right problem, it provides frameworks to create and test assumptions about their idea and provide recommendations towards next steps. ON Prime can be considered as an entry level program, in effect it can be seen as a precursor to participation in the ON Accelerate program.

ON Accelerate is designed for teams that have made significant progress with their idea and their target market(s). This may be in the form of contracts for paid or unpaid trials, or at the most advanced stage, recurring sales with both new and existing customers. This implies that teams will have a working prototype of their product or service and have secured any appropriate intellectual property rights. It is expected that teams applying for ON Accelerate would have conducted significant engagement with their potential customers and be able to demonstrate what they learned throughout, including what the total addressable market is and what competition exists.

For ON Accelerate, shortlisted applicants are invited to participate in a two-day Selection Bootcamp event where teams will be provided with training and coaching simulating the accelerator experience. At the conclusion of the selection bootcamp, the teams will pitch to a panel of external judges for a spot in the Accelerator. Projects that are at Investment Readiness Level (IRL) Stage 3 can apply directly for ON Accelerate without going through Prime or Bootcamp.

Following a team’s passage through the ON Prime or ON Accelerate program they are eligible to apply for ON Runway support. That funding is designed to help teams to further progress their project. The support provided can be spent on a range of services, for example, regulatory certification, marketing, bookkeeping or investor agreements.

## Background

Bananas are Australia’s largest horticultural industry. There are currently 13,000 hectares of land used for banana production, more than 95% of which is in North Queensland.

Banana cultivation generates a large amount of residue since each plant produces only one bunch of bananas. After harvesting the remainder of the plant is usually chopped down and left to decompose on the plantation floor, which takes around four months due to the waxy nature of the green material. The banana harvesting residues are regarded as waste and a source of environmental pollution.

Bananas are an important crop. Global production in 2015 was 117.9 million tonnes. In 2016/17 Australian banana production was 414,000 tonnes, which resulted in approximately 800,000 tonnes of plant waste.[[1]](#footnote-1)

The BananaWax research team has developed a technology to extract high value wax from the leaves of banana plants. Natural waxes can be used for a number of purposes including candles, packaging, food, coatings and polishes, hot melt adhesives, tyres and rubber, cosmetics and personal care.

There is an increasing worldwide demand for bio-based waxes, however there are limited sources of these waxes with few plants producing economically viable amounts of wax. A common natural wax is Carnauba wax, extracted from the leaves of the Carnauba tree, which is grown in northern Brazil. Carnauba wax is popular because of its high melting point, hardness, toughness and lustre. The Carnauba wax market is expected to grow due to its use as a food glazing agent where it can provide a superior shine. The Carnauba wax market is projected to reach $335 million by 2024.[[2]](#footnote-2)

The BananaWax team have come up with a more ecologically friendly alternative to Carnauba wax to meet the world’s growing demand for wax. BananaWax can provide a local alternative to imported industrial waxes, assist banana farmers to diversify and generate auxiliary income, and stimulate the local economy. In addition, the technology utilises a waste material which will have a positive impact on the environment.

## Impact Pathway

### Project Inputs

The total cost for the BananaWax project was $78,430 in cash and in-kind contributions (see Table 1.1). The team received $50,000 in seed funding from the Institute for Future Environments at Queensland University of Technology (QUT) (around 64% per cent of the total cost). The funding was used to pay for:

* A research assistant
* Materials and consumables
* Travel to research facilities
* Market testing and analysis.

In addition, there were in-kind contributions of around $28,430 associated with personnel time, travel, and access to laboratories and analytical equipment.

Table 1.1 Support for the project

| Contributor / type of support | | Year 1 ($ m) | |
| --- | --- | --- | --- |
| **Cash** | |  |
| QUT | | $50,000 |
| **In-kind** | |  |
| Bioinformatician salary | | $8,173 |
| Research Fellow salary | | $12,257 |
| Travel to research facilities | | $1,000 |
| Access to laboratories | | $7,000 |
| **Total** | | **$78,430** |

The value of resources that CSIRO devoted to supporting the BananaWax project in the ON Prime program is $18,506.

### Project activities

The BananaWax team analysed the wax component of 16 different banana varieties and found different ways of extracting the wax off banana leaves, which can then be used in a variety of different products instead of imported Carnauba wax.

###### Role of the ON program

Four BananaWax team members participated in the ON program over the period from September to November 2018. The BananaWax team identified a range of benefits from their participation in the ON program, namely:

* a better understanding of the problems and solutions regarding banana tree waste
* a better understanding of farmers’ priorities
* learning more about wax and its uses
* establishing that there is a high demand for bio-based waxes (as a result they changed their value proposition to fit the market need)
* identifying the key potential markets for the wax (car accessory companies, the cosmetic industry and food manufacturers)
* identifying key stakeholders to speak to, obtaining useful contacts, and gaining the confidence to contact other stakeholders to discuss business opportunities
* gaining the confidence to proceed with their research.

The BananaWax team believe that without their participation in the ON program they would not be where they are now. In particular, through the ON program they met the owner of a local Queensland company who is interested in trialling the use of banana wax in the car polish his company manufactures. If it is suitable, he has offered to collaborate further with the researchers.

### Project outputs

The BananaWax team has successfully demonstrated the laboratory scale extraction of banana wax from banana waste. They have also developed a better understanding of banana growers needs and identified a priority potential market for banana wax.

It is currently in discussions with the Southern Cross University in Lismore to undertake larger scale extraction of wax from some fifty kilos of banana waste. It is estimated that around 350g of wax could be extracted from this amount of waste. The intention is to trial the use of the extracted wax in car polish. Car polish only includes a relatively small amount of wax.

#### Publications

The BananaWax team plan to finish their analysis, prepare a scientific paper and publish it. Through the ON program the research team obtained a contact at the Banana Growers’ Council. The Council is interested in publishing the team’s research in their magazine.

The research team is planning to conduct a consumer survey in early March 2019 to identify customer preferences regarding car wax (discussed in Section 1.3.5) and intend to publish the results in a modelling report.

#### Patents

The BananaWax team intends to talk to QUT BlueBox (QUT’s commercialisation arm) about patents for the wax.

#### Awards

The BananaWax team have not won any awards.

#### Innovation / commercialisation

If the wax testing is successful, the next stage of the process will be to investigate the economic and engineering aspects of wax extraction. Ideally the BananaWax team would like to engineer small on-farm extraction plants which farmers could use to extract the wax from banana waste. On-farm processing would help overcome the high cost of labour and transportation.

In addition to extracting wax off banana leaves, the researchers would like to find a purpose for the leaves once the wax has been extracted. Possible options may include use in bioplastics, animal feed, biochar or biofuel.

The successful collaboration with QUT has led to discussions about opportunities for other related research projects the two groups might collaborate on, such as bioplastics or animal feed.

###### Role of ON program

Through the ON program the BananaWax team identified eight farmers interested in trialling wax production crops and three companies who interested in experimenting with BananaWax.

The team is currently working to develop and fine tune their product and supply wax to companies to test the product. They will then revisit their business model canvas.

### Project Outcomes

The objectives of BananaWax are to provide a more ecologically friendly and local alternative to imported industrial waxes, assist banana farmers to diversify and generate auxiliary income, stimulate the local economy and utilise a waste material.

###### Role of the ON program

The ON program has advanced the BananaWax project by around 6-12 months.

### Adoption

The BananaWax team does not have any information on what the potential uptake of banana wax by the Australian or overseas markets might be.

The competing product for banana wax is Carnauba wax. Raw Carnauba wax currently sells for around $30 kg. The cost of mass‑producing banana wax in Australia is currently unknown. However, to be competitive the cost would need to be the same or less than the cost of the competing product (Carnauba wax). Box 1.1 provides some information on the market for Carnauba wax.

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| Box 1.1 The market for Carnauba wax. |
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| Manufacturers are mostly based in Brazil due to the abundance of raw material in the region. The wax is extracted from the leaves of the Brazilian palm tree. It is then filtered and processed. The extraction and processing are highly labour intensive leading to a higher labour cost. Filtering and processing are not capital intensive, leading to low setup costs for manufacturers. The global Carnauba wax market size was US$246.0 million in 2015 and is forecast to be US$335 million by 2024.  There are three carnauba wax products, type 1, type 3, and type 4. Type 1 is the purest form of the product and has high demand in niche applications such and pharmaceutical, food products and premium automotive wax formulations. Sales of Type 1 were over US$92 million in 2015. Increasing demand for the product in fruit coatings is expected to drive the demand for the Type 1.  Type 3 and type 4 wax are dark in colour and are used in automotive applications, industrial polishes, and in leather tanning industry. It is also used to impart gloss to various products such a lip colours and nail polishes.  Demand growth in Asia Pacific is expected to be driven by uses such as food glazing agents in the developing food and confectionery industry in China. Increasing adoption of the product in the automobile industry is also expected to accelerate market growth, particularly in the Asia Pacific region. |
| Source: Market report by Grand View Research, 2016, <https://www.grandviewresearch.com/industry-analysis/carnauba-wax-market> Accessed January 2019 |

The BananaWax team’s current focus is on supplying banana wax to the car wax market. To better understand this market the researchers will be surveying car owners through car clubs to assess how car owners’ preferences regarding different properties (origin, durability, shine, major ingredient and price) affect their selection of car wax. The survey data will be aggregated to identify the most important features of wax for car enthusiasts and determine an acceptable price point. The survey will also collect data on the social and economic background of respondents to provide further insights into consumers of car wax.

###### Role of the ON program

The team’s progress in testing the potential uptake of banana wax in the car market is a direct result of the contacts they made through the ON program.

### Impacts

There are no actual impacts flowing from the BananaWax project yet, as the project is still in its early stages. However, the case study has identified several potential benefits of the BananaWax technology, namely:

* a potential source of additional income for banana growers
* potential environmental benefits from a reduced waste stream
* a more environmentally friendly source of wax
* potential opportunities to supply to the domestic and export market.

Based on the information currently available, the maximum amount of wax that could be produced from Australia’s banana waste is about 5,600 tonnes. Given the status of the technology it is necessary to make several assumptions in order to estimate the potential benefits of this project. We have made the following assumptions:

1. The amount of banana waste used as a source of wax extraction is around one per cent of the total available banana waste. This would produce 56 tonnes of wax.
2. The value of the wax is $30/kg. This would imply a total value of around $1.68 million in first year of production.
3. Production of banana wax begins in 2022. In the absence of the ON program production would have begun in 2023.
4. Production increases gradually each year from 2022 to 2028 after which it remains stable (see also discussion in Section 1.5.1).

## Clarifying the Impacts

### Counterfactual

In the absence of the ON program the BananaWax team would not have come as far as they have during this time. They would not have spoken to as many people as they have and may not have identified their key markets. All the stakeholders they have met have been through their participation in the ON program.

For the purposes of our analysis, ACIL Allen have assumed that in the absence of the ON program BananaWax’s growth path would have been delayed by around 12 months.

### Attribution

ACIL Allen has attributed the entire difference between the NPV of the assumed growth in the market for BananaWax with and without the support provided by the ON program to that program.

## Evaluating the Impacts

### Cost-Benefit Analysis

* + - 1. **Costs**

The costs to the BananaWax team of participating in ON program activities are estimated to be $25,000. The overhead costs of the ON program that have been apportioned to the BananaWax project total $18,506. Both sets of costs are assumed to be incurred in 2018.

* + - 1. **Benefits**

ACIL Allen has estimated the potential benefits of banana wax in relation to the manufacturing of BananaWax-based car wax in Australia.

The global car wax market in 2018 has been estimated at US$743.5 million (approximately A$1,047 million at current exchange rates) and is expected to grow at 4.2 per cent per annum until 2028[[3]](#footnote-3). In 2018, 1.153 million new cars were sold in Australia, compared with 78.7 million worldwide[[4]](#footnote-4). Assuming that the size of the Australian car wax market relative to the global car wax market is proportional to the number of new cars sold in Australia versus globally, we estimate the Australian car wax market to be worth A$15.34 million in 2018. We assume that the Australian car wax market will grow at the same rate as the global car wax market.

We assume that BananaWax-based car wax will begin to be manufactured in Australia in 2022. In that year, it is assumed to command a 2 per cent share of the Australian car wax market. Between 2022 and 2028, it is assumed that this market share will rise by 0.5 per cent a year, reaching 5.0 per cent in 2028 before flatlining.

It is assumed that the introduction of BananaWax-based car wax in Australia will be delayed by a year in the absence of the ON program, but the evolution of market share will have a similar profile as that with the ON program (albeit displaced by one year). The market share of banana wax in the Australian car wax market between 2021 and 2032 with and without the ON program is shown in Figure 1.2.

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| Figure 1.2 Market share of BananaWax in Australian car wax market with and without ON program, 2021 to 2032 |
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| Source: ACIL ALLEN |
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Based on the market share profiles shown above and the projected growth of the Australian car wax market, the projected sales of BananaWax-based car wax in Australia between 2022 and 2038 with and without the ON program is shown in Figure 1.3.

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| Figure 1.3 BananaWax car wax sales in Australia, 2021 to 2032 ($M) |
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| Source: ACIL ALLEN |
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It is assumed that most of the value added in BananaWax-based car wax production is retained in Australia, with only 20 per cent “leaking” out of the Australian economy (due, for example, to some foreign-sourced inputs).

* + - 1. **Assessment of benefits against costs**

The present value of ON-related costs is estimated to be $47,500 in 2019 dollars under a 7 per cent real discount rate. The present value of potential benefits from the accelerated introduction and production of BananaWax-based car wax in Australia as a result of the ON program is estimated at $559,500 in 2019 dollars under a 7 per cent real discount rate.

The net benefit or net present value (NPV) of the ON program in relation to BananaWax is thus estimated at $511,900 in 2019 dollars under a 7 per cent discount rate. The benefit-cost ratio (BCR) is estimated at 11.8.

* + - 1. **Sensitivity analysis**

Sensitivity analysis was undertaken to test the robustness of the cost-benefit analysis to changes in key assumptions and parameter values.

In the central case of the cost-benefit analysis, an annual growth rate of 4.2 per cent is assumed for the Australian car wax market. If the annual growth rate is 6.2 per cent, the BCR rises from 11.8 to 13.2. Conversely, if the annual growth rate is 2.2 per cent, the BCR falls to 10.5.

In the central case of the cost-benefit analysis, it is assumed that the initial market share of BananaWax-based car wax in Australia is 2 per cent. If the initial market share is 3 per cent, the BCR rises from 11.8 to 14.3. Conversely, if the initial market share is 1 per cent, the BCR falls to 9.3.

In the central case of the cost-benefit analysis, the market share of BananaWax-based car wax in Australia is assumed to grow by 0.5 per cent annually. If the annual growth rate is 0.75 per cent, the BCR rises from 11.8 to 15.2. Conversely, if the annual growth rate is 0.25 per cent, the BCR falls to 8.4.

In the central case of the cost-benefit analysis, it is assumed that 20 per cent of the value added in car wax production in Australia is “leaked” out of the Australian economy due to foreign-sourced inputs etc. If the leakage is 30 per cent instead of 20 per cent, the BCR falls from 11.8 to 10.3. If the leakage is only 10 per cent, the BCR rises to 13.2.

The central case of the cost-benefit analysis is undertaken using a 7 per cent real discount rate. The BCR is 14.0 and 10.0 under a 4 per cent real discount rate and a 10 per cent real discount rate respectively.

### Potential future impacts

If the trials of using BananaWax in car polish are successful, then BananaWax could increasing its share of the car wax market and also expand into other industries such as cosmetics and food production. If this occurred, then demand could grow more quickly than currently estimated. This could lead to increased profits from the production of BananaWax, and a source of additional income for banana growers.

### The ON program’s role

BananaWax’s participation in the ON program has helped the team to better understand the problems and solutions regarding banana tree waste; better understand farmers’ priorities; and identify key markets for the wax. Importantly, it also allowed the researchers to meet key stakeholders – including the owner of a local Queensland car care company who is going to trial the use of banana wax in his company’s car polish.

1. Figures provided in the synopsis for a research paper that BananaWax research team is preparing. [↑](#footnote-ref-1)
2. Market Report by Grandview Research, 2016, <https://www.grandviewresearch.com/industry-analysis/carnauba-wax-market>, accessed January 2019. [↑](#footnote-ref-2)
3. <https://www.futuremarketinsights.com/reports/car-wax-market>, accessed on March 5, 2019 [↑](#footnote-ref-3)
4. <https://www.statista.com/statistics/200002/international-car-sales-since-1990/>, accessed on March 5, 2019 [↑](#footnote-ref-4)