

# Supplementary Material

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**Table S1.** Survey Question Grid

Qualtrics Survey for Stakeholders			
Topic	Survey Question	Options	Reference/Rationale
Background Information	1. Which of the following best describes your company/business?	Primary Producer (Farmer) Wholesaler Secondary Producer (Food Processor) Retailer Hospitality/Restaurant/Café Other.	It will be important to capture information from all aspects of the food chain, as food waste is experienced across all sectors. [46]
	2. Can you please indicate the size of the company/business?	Micro (<10 employees) Small (<50 employees) Medium (50-249 employees) Large (>250 employees)	It is important to explore if the size of the company has an effect on how they deal with fruit and vegetable surplus (Answering EQ1a) SME Definition - Enterprise Ireland (enterprise-ireland.com)
	3. What is your role within the company/business?	Owner Manager Quality Product Development / Research and Development	<b>Answering EQ1b</b> This question will allow for a clear picture of the impact of food waste

		Production Chef Sales Other... give option to write exact job title	management has across all areas within the different business models. Beausang et al. [18] showed how the views from Primary producers are not necessarily the same as those in retail for example as each stakeholder has different targets or key performance indicators (KPI's). Göbel et al., [46] reviewed how cooperation across the supply chain is required to reduce food waste.
	4. In which province is your company/ business based?	Ulster Connacht Munster Leinster Nationally	Since this survey will be advertised through social media, it will be important to have an idea of the distribution of the participants to help our discussion
	5. Which of the following terms best <b>describes</b> the food surplus* present within your company/business? <i>Tick all that apply.</i>	<ul style="list-style-type: none"> <li>- Whole fruits and or Vegetables that do not meet specifications (retail, food safety etc)</li> <li>- Peels, Pips, cores or other by-products generated by processing.</li> <li>- Inedible material (that is not fit for human consumption)</li> <li>- Spoiled /contaminated product within best before / use by dates.</li> </ul>	<b>Answering EQ1b</b> Mirabella et al. [19] and Garcia-Garcia et al. [27] discuss the use of by-products and side streams to develop new revenue streams. It is

	<i>*any fruit/veg raw material that is not used up in your normal manufacturing operations.</i>	<ul style="list-style-type: none"> <li>- Product that has exceeded its best before/use by date.</li> <li>- Other please specify.</li> </ul>	important to understand what is present in the Stakeholders business so we can identify what is possible in terms of adding value. Papargyropoulou et al. [9] reviews the food waste hierarchy for ways of managing food surplus and waste.
	6. Do you record the amount of surplus material generated in your company/business?	<ul style="list-style-type: none"> <li>- Yes</li> <li>- No</li> <li>- Not sure</li> </ul>	Those discussing ways of reducing food losses and waste along the supply chain comment that measurement is a critical step to achieving effective waste reduction [8]
	7. Could you please estimate the quantity of surplus material present within your company/business?	<ul style="list-style-type: none"> <li>- &lt;30 tonnes per annum</li> <li>- 30-50 tonnes per annum</li> <li>- &gt;50 tonnes per annum</li> <li>- Other Value (allow text entry)</li> <li>- Prefer not to say</li> <li>- Not sure</li> </ul>	
<i>According to the Food and Agriculture Organization (FAO)'s 2011 definition, Food losses occur in the early stages of the food supply chain, while food waste occurs at the distribution and consumption stages, keeping this in mind can you please address the following questions.</i>			[1]
	8. How would you classify / characterize any surplus fruit and vegetables within your company/business?	<ul style="list-style-type: none"> <li>- Food Losses</li> <li>- Food Waste</li> <li>- Material for further food processing (in house or third party)</li> <li>- Material for animal feed</li> <li>- Other open</li> </ul>	<b>Answering EQ1a</b> Papargyropoulou et al. [9] , Chaboud and Daviron [3] and Nicholes et al., [7] highlighted the difference between food

			surplus and food waste, referencing the waste hierarchy, it is important to this research to get a clear understanding of how each of the stakeholders classify their excess fruit and vegetable material.
	<p>9. What do you think is the main contributor to food loss or waste within your company/business? <i>Please choose the 3 main contributors</i></p>	<p>Raw Material Quality Production inefficiencies Forecasting/predicting orders Over production Quality/Food Safety Specifications Retailer Requirements Consumer Expectations</p>	<p><b>Answering EQ1a</b> Numerous publications noted many reasons for excess waste material, with retailer requirements and quality specifications a key requirement causing a lot of material to be rejected at primary and processing stages of the food supply chain. [18, 46, 52]</p>
	<p>10. Considering the surplus material generated within your company, please read each statement and score on the line scale, how much you agree or disagree with that particular statement?</p>	<ol style="list-style-type: none"> <li>1. food surplus generated in our business is a problem</li> <li>2. there are government incentives to deal with food surplus in our business</li> <li>3. there is management initiative to deal with food surplus in our company</li> <li>4. it is expensive to deal with food surplus in our company</li> <li>5. it is important from an environmental point to deal with food surplus</li> </ol>	<p><b>Answering EQ1a</b> (Chaboud and Daviron [3] discuss the many factors to consider when addressing the food surplus present in companies or business, it's important to understand the motives</p>

		6. there is not enough time in our company to deal with food surplus 7. there is lack of information on how to deal with food surplus 8. it is the company's ethos to deal with food surplus 9. it is expected to deal with food surplus by our customers	around the management of this surplus in order to address ways of adopting a more circular approach.
	11. Have you identified any side streams* for some or all of the surplus material present?  <i>*An example of a side stream would be using excess potatoes that do not meet retail specifications to develop potato starch for a separate market</i>	- Yes - No  <i>(answer will direct the respondent to the next appropriate question)</i>	<b>Answering EQ2</b> Mirabella et al [19] showed a variety of waste to value food production processes that are currently being explored at pilot stage development. It is important to see if any of these avenues are being used by Irish companies. [27,31]
	12. If yes, please select the stream that best describes this function.	- Animal Feed - Bioenergy Production - Value added food production <i>(for example re-using a surplus component as an ingredient in a new product, hence adding value)</i> - Redistribution of food for human consumption - Other please specify	
	13. If no, how do you currently dispose of this material?	- General Waste - Composting - Anaerobic Digestion - Segregated for (Brown Bin) Collection Service - Other please specify	The EU farm to fork [5] strategy identifies reducing food waste as having a positive impact on environmental issues the planet is currently experiencing, such as

			greenhouse gas emissions and biodiversity loss, it would be important to understand how stakeholders are currently managing their waste streams. Also, the qualitative research conducted with consumers as part of this project showed numerous differences in relation to how food waste is managed due to location, it would be important to identify if this is also a factor within the Fruit and Vegetable processing sector.
<p><i>If you are interested in following up on this survey to share your views on this topic, by taking part in a short one to one interview, please contact Ms Shelley Fox to receive further information</i></p>			

**Table S2.** Interview Question Grid

Interview Question	Prompts	Rationale/Reference
1. Introductory information (i) what sector do you work in? (ii)Where in the country is your company/business located? (iii) What is the size of your company?	(i) Farmer, producer, hospitality, wholesaler, retailer (ii) province (iii) Micro, SME or large	<b>To meet the sample set, see appendix 7 sample triangulation.</b>
2. How often do you measure any surplus* fruit and vegetable materials remaining after your main production is completed? <i>*any fruit/veg raw material that is not used up in your normal manufacturing operations.</i>	Daily, weekly, quarterly etc.	<b>Answering EQ1a</b> The EU Commission 2019; UNEP 2021 generated a code of conduct to achieve the SDGs [4,8], it is important to understand how stakeholders are measuring this surplus material as part of the farm to fork strategy is collecting data from all member states so they can establish a base line and set legally binding targets to reduce food waste across the EU.
3. What happens with this information gathered?	Run trends, measured against departments KPI's etc	
4. What is the main reason for including this metric in your business model?	Is it public policy, Company KPI's, Lean Manufacturing Principles etc	<b>Answering EQ1a</b> Garcia-Garcia et al., [27] looked at categorising food waste using the waste hierarchy, and ways of minimising environmental, social and economic impacts. (EU Commission 2021) is establishing set targets and policies for member states [8].
<i>In 2015 the UN identified 17 sustainable development goals (SDGs), reducing food waste is the focus of SDG 12.3, in line with this goal and the EU's Farm to Fork strategy, the Irish Government is aiming to meet these targets and reduce our national food waste by 50% -</i> 5. Have you seen evidence of these National and EU targets within your sector?		<b>Answering EQ1a</b> Ireland's national waste policy 2020-2050 is detailed in Ireland's Circular Economy publication, this is in line with the UN's SDG 12.3  Waste Framework Directive (2018/851/EC) and Farm to Fork policy

If yes, do you believe these targets are achievable?		<p>United Nations General assembly (UN) (2015)</p> <p>Lemaire and Limbourg, [2] reviewed achieving SDG's.</p> <p>(Richards et al.,[52] looked at the many paradoxes in policies focusing on specific points and not treating the issue across the supply chain.</p>
6. Can you please describe the types of products or by-products you have surplus of?	Peels, trimmings, cores, pulp, whole fruits or vegetables	<p><b>Answering EQ1b</b></p> <p>(Chaboud and Daviron [3] there are a lot of inconsistencies in terms of food losses and waste, it is critical to understand what types of products companies have surplus of and what they maybe do not consider as waste.</p>
7. Can you identify the main reasons for this surplus, considering your company/business? <i>For example, if you consider your raw material suppliers and your customers</i>	It's not needed in the finished product, it's the inedible part of the product that is not safe to consume, it doesn't meet customer specifications.	<p><b>Answering EQ1b</b></p> <p>Richards et al., [51] identifies issues with supply and demand that may lead to excess production and potential losses.</p> <p>(Beausang et al.,[18]) FAO [44], Göbel et al. [46] – all mention that retailer specifications, derived by consumer expectation of cosmetic criteria drives up food waste.</p>
8. How do you currently deal with any surplus fruit and waste material within your company/business?		[4,8]
9. Has your company looked at adding value to this surplus material?	As a new ingredient in a different product, for example	<p><b>Answering RQ2</b></p> <p>Mirabella et al. [19] noted that modification of waste streams and ensuring food safety may be costly, a high value-added product would need to be justified.</p>



10. If yes, can you indicate what field of development your company/business has explored? ( <i>ensuring not to compromise company confidentiality or non-disclosure agreements</i> )	Bioenergy, new food products, as a raw material for other producers and so on	<p>Answering RQ2</p> <p>Mirabella et al.,[19], Garcia-Garcia et al.,[27], Zuin et al., [28] and Sagar et al., [25] all highlight many research opportunities for valorising fruit and vegetable waste /side streams.</p>
11. If no, would you be interested in exploring adding value to these ingredients? And how would you go about this?	New product development, exploring sales of by-products as they are	
12. What do you see as the benefits of adding value to this surplus material for your company?		
13. What barriers have you experienced or would you expect to find when adding value to this material?		

**Table S3.** Sample of Coding file (Thematic Analysis -Phase 2 descriptive loose codes)

Question	Codes	Participant	Quotes
2	A la carte menu creates more waste, tasting menu is tighter and more manageable	3	<i>We had an a la carte menu on previously, before COVID. And we had a lot of waste. We were buying a lot of produce there. And there was a lot of waste but now, the tasting menus is kind of a tighter menu and the orders are tighter.</i>
	Trying to minimise waste	2	<i>Not measuring, trying to minimize most</i>
	Exact orders to match customers	3	<i>we order exactly what we need in and we use it and then we start again fresh, because you know exactly how many customers are in the bill, on that day, what they're going to order</i>
	Covid factor changing how business is run	3	<i>We had an a la carte menu on previously, before COVID. And we had a lot of waste. We were buying a lot of produce there. And there was a lot of waste but now, the tasting menus is kind of a tighter menu and the orders are tighter.</i>
	Adhoc measuring	4	<i>we wouldn't be measuring it strictly like we are measuring it</i>
	Everything is used	5	<i>Everything is used</i>
	There is a loss or a waste factor	6	<i>anything that we use prepared for our customers, we buy that in, so in everything, there is either a loss or a waste factor at the end</i>
	There is a reporting structure for everything	6	<i>for sustainability credentials, and there is a reporting structure behind everything that we do</i>
	sustainability credentials	6	<i>for sustainability credentials, and there is a reporting structure behind everything that we do</i>
	Clear waste targets	7	<i>we would have very clear waste targets. So all our all our departments, and all our departmental managers have waste targets</i>
	Part of KPIs to manage food waste	7	<i>part of their weekly and annual and quarterly KPIs that they will manage foodwaste.</i>
2b	80/20 rule (80% reduced, 20% waste) dependent on product lines	7	<i>we always try to go through 80/20, 80% reduced, 20% waste. But it doesn't work like that at all. There's some weeks you could have 80% waste and 20% reduced, depending on the product lines.</i>
2b	Time factor	4	<i>it's kind of on an ad hoc basis really, probably time that's being honest with you, probably due to time</i>

	Buying in peeled produce to reduce labour/time	4	<i>we used to peel all our own potatoes, we used to peel the onions and all that now we're buying in our potatoes processed, they're coming in 9 kilo, it's another company who's doing that.</i>
	Removing labour intensive part of production	4	<i>we have a processing kitchen but we're removing the labour intensive part of it, if you can get me it is either a big investment or stop doing what we're doing.</i>
	Big investment required or stop what you are doing	4	<i>we have a processing kitchen but we're removing the labour intensive part of it, if you can get me it is either a big investment or stop doing what we're doing.</i>
	Covid factor changing how business is run	4	<i>we were for employing people four or five people to cut out the eyes out of the potatoes at the end. And then there were being they were going into a preservative and then they were being bagged. And when COVID hit. Everyone thought that we were closed because we were a food processing business, but we actually weren't, we remained open. But we obviously lost all the hotels, all the restaurants, all them places closed. So there was there was takeout happening. So there was a lot less stuff happening. But we didn't have enough work to provide our full time employees work.</i>
	Difficult to get staff to do certain jobs	4	<i>it's getting harder and harder to get people to do this particular task. There are companies out there who have made huge investment and we just decided to go on and buy that buy finished products direct from them and trying, try and try and try and get our margins in on that.</i>
	Companies who have invested in equipment now supplying prepared produce	4	<i>It's getting harder and harder to get people to do this particular task. There are companies out there who have made huge investment and we just decided to go on and buy that buy finished products direct from them and trying, try and try and try and get our margins in on that.</i>
3	Traceability	1	<i>We have this true traceability exercises. You have all production loads, how much you used? What's waste,</i>
	Internal and External audits	1	<i>Its used for our own internal audits for the external audits.</i>
	Should be focusing on measuring waste to get a good price for finished product	4	<i>Like if to be honest. It's probably something that we should be focusing on a lot more particularly for, you know whom we're trying to get the price, we're trying to price our products, our finished products going out.</i>
	Aware of losses	4	<i>I know that a ton of carrots goes in one end of the machine, and I know give or take, you know, you're talking about a somewhere between 70 and 80% come out for processing. So you lose kind of 30% of your tonne. So you're losing, you know, 300 kilos</i>

	Time factor	4	<i>we probably should be spending more time on it and analyzing it more. It's just, it's time based, it's very hard.</i>
	Management resource strain	4	<i>You know, we've people employed in the processing kitchen. And we're kind of operational, and it's just that's the way it is. We know that if we were in there, we probably have a much better understanding and a much clearer understanding of what the exact waste is on every product that goes in, but it's just it's just the nature of the business. It's something that we just don't have nailed down yet.</i>
	Internal and External audits	6	<i>We use it for audits for, we'll say sustainability credentials, we had Origin Green Gold, we were the only company in Ireland that had that.</i>
	sustainability credentials	6	<i>We use it for audits for, we'll say sustainability credentials, we had Origin Green Gold, we were the only company in Ireland that had that.</i>
	Review ordering procedures	6	<i>we have a stock count and balance. When we look at our ordering procedures, we'd look at the weather forecast.</i>
	Weather factor	6	<i>we have a stock count and balance. When we look at our ordering procedures, we'd look at the weather forecast.</i>
	Everything has a record	6	<i>everything has a record at the end of what we have that we cannot, it's not fit for human consumption. By the time we have figured out what avenue we can take with that to get it sold to make it of value to somebody.</i>
	Produce can be of value to someone, until it is not fit for human consumption	6	<i>everything has a record at the end of what we have that we cannot, it's not fit for human consumption. By the time we have figured out what avenue we can take with that to get it sold to make it of value to somebody.</i>
	Loss and reduction values linked to accounts system	7	<i>we have a system called pyramid, which is our account system, the account system. So we scan all our waste. So if we dump a bag of carrots or put a bag of carrots in to reduce to clear, we have a scan and a wand system we wand the waste or wand the reduction. And it picks up the reduction values.</i>
	Weather related losses	7	<i>each department will ultimately be causing waste. So we look at factors around whether you know, so we'd be looking like last week was significant, obviously heat, so you'd have a significant reduction in veg or high increase in sales in bag salads.</i>
	Increased sales in certain items due to changes in weather	7	<i>each department will ultimately be causing waste. So we look at factors around whether you know, so we'd be looking like last week was significant, obviously heat, so you'd have a significant reduction in veg or high increase in sales in bag salads.</i>
	Forecasting	7	<i>we do a lot of forecasting on a weekly basis, so we'd we knew the weather was going to be hot next week. We take that into consideration bearing in mind that if your veg will probably fall off the off the Richter scale</i>

	Weather factor	7	<i>we do a lot of forecasting on a weekly basis, so we'd we knew the weather was going to be hot next week. We take that into consideration bearing in mind that if your veg will probably fall off the off the Richter scale</i>
	Get it right first time	7	<i>we have a policy of saying, getting it right first time.</i>
	Waste is dead money	7	<i>its a number of factors but waste. We see waste as absolutely dead money.</i>

**Table S4.** A discussion of recent methodologies for combining sensory and extrinsic product properties in consumer studies

Q2 Are you measuring any surplus fruit and vegetable materials remaining after your main production is completed? How often do you measure them? <i>If not what are the reasons for not measuring?</i>				
Potential Theme Phase 4	Categories (Initial themes) Phase 3	Associated Codes	Quotes	Participant Number
Time	Time Factor	Time factor	<i>it's kind of on an ad hoc basis really, probably time that's being honest with you, probably due to time</i>	4
		Buying in peeled produce to reduce labour/time	<i>we used to peel all our own potatoes, we used to peel the onions and all that now we're buying in our potatoes processed, they're coming in 9 kilo, it's another company who's doing that.</i>	
Labour	Labour factor	Buying in peeled produce to reduce labour/time	<i>we used to peel all our own potatoes, we used to peel the onions and all that now we're buying in our potatoes processed, they're coming in 9 kilo, it's another company who's doing that.</i>	4
		Removing labour intensive part of production	<i>we have a processing kitchen but we're removing the labour intensive part of it, if you can get me it is either a big investment or stop doing what we're doing.</i>	
		Difficult to get staff to do certain jobs	<i>it's getting harder and harder to get people to do this particular task. There are companies out there who have made huge investment and we just decided to go on and buy that buy finished products direct from them and trying, try and try and try and get our margins in on that.</i>	

		Companies who have invested in equipment now supplying prepared produce	<i>It's getting harder and harder to get people to do this particular task. There are companies out there who have made huge investment and we just decided to go on and buy that buy finished products direct from them and trying, try and try and try and get our margins in on that.</i>	
<b>Impact of covid</b>	Covid Impact	Covid factor changing how business is run	<i>we were for employing people four or five people to cut out the eyes out of the potatoes at the end. And then there were being they were going into a preservative and then they were being bagged. And when COVID hit. Everyone thought that we were closed because we were a food processing business, but we actually weren't, we remained open. But we obviously lost all the hotels, all the restaurants, all them places closed. So there was there was takeout happening. So there was a lot less stuff happening. But we didn't have enough work to provide our full time employees work.</i>	4
<b>Economic factors</b>	Investment required	Big investment required or stop what you are doing	<i>we have a processing kitchen but we're removing the labour intensive part of it, if you can get me it is either a big investment or stop doing what we're doing.</i>	4