



## Food Institutional Research Measure

### Final Report

Disaggregation of food consumption databases to raw agricultural commodity values for estimation of intakes of pesticide residues, RACConvert

DAFM Project Reference No: 14/F/813

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Please place one "x" below in the appropriate area on the research continuum where you feel this project fits

Basic/Fundamental		→	Applied		→	Pre Commercial	
1	2	3	4	5	6	7	
			X				

Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise\* (NRPE) report;

Priority Area (s)	H Food for Health
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Key words: (max 4) Dietary intake Pesticide Residues

## **1. Rationale for Undertaking the Research**

The rationale behind this project was to further develop the Irish National Food Consumption databases developed by the IUNA ([www.iuna.net](http://www.iuna.net)) to facilitate estimates of food chemical intake, specifically pesticide residues. The IUNA food consumption databases are among the most comprehensive in the EU and include nationally representative data on food consumption, nutrient intake and status, body weight, blood pressure, and lifestyle behaviours. They are designed to address both nutrition and food safety issues.

This project was based on the analysis of the two most recently developed databases at the time of project commencement, i.e. in adults aged 18-90 years (n 1500) (the National Adult Nutrition Survey, NANS) and children aged 1-4 years (n 500) (the National Pre-school Nutrition Survey, NPNS). The research converted both datasets to a disaggregated form which could facilitate public health risk assessments. In particular, published conversion factors were applied so that individual ingredients could be re-converted to raw agricultural commodities (RACs) thereby facilitating a range of assessments of food chemical intake, such as those for intake of pesticide residues. The datasets generated can directly support the activities of a range of stakeholders e.g. the Food Safety Authority of Ireland, the Pesticides Control Services Unit of the Department of Agriculture, Food and The Marine and the European Food Safety Authority. The project further developed capacity of Irish researchers to participate in JPI and Horizon 2020 with research outcomes disseminated to key stakeholders.

## **2. Research Approach**

The research involved the analysis of two nationally representative databases on food consumption, i.e. the National Adult Nutrition Survey (NANS) carried out 2008-10 and the National Pre-school Nutrition Survey (NPNS) carried out 2010-11. The research expanded upon previous and ongoing analysis of the databases by firstly disaggregating and converting existing food consumption databases to raw agricultural commodities and secondly completing risk assessments of dietary intake of pesticide residues by Irish adults and Irish preschool children. Such assessments were completed with input and provision of concentration data from the Pesticide Control Services Unit at the Department of Agriculture Food and the Marine and with guidance from the Food Safety Authority of Ireland as part of a project Scientific Advisory Committee involving both UCC and UCD.

Specific methodological considerations are outlined below:

- Food consumption surveys typically record intakes of foods as they are consumed – e.g. bread or granulated sugar. In contrast, analysis of pesticide residues is performed on raw agricultural commodities (RACs, e.g. wheat or sugar beet) to check compliance with maximum residue levels (MRLs) as set in Regulation (EC) No 396/2005. As RACs refer to produce in its raw state prior to any form of processing, the first step of this project was to convert foods as consumed to the edible forms of their respective raw agricultural commodities (edible RACs or e-RACs).

- The second step, dietary exposure assessments, were completed using a tiered approach combining the RAC estimates with pesticide concentration data obtained from the National Pesticide Residues Control Programme for the period 2012-2014 (this Programme being completed by the Pesticide Control Services Unit at DAFM). The pesticides selected were the five most commonly detected pesticide residues analysed in the Irish national control programme. They were: chlorpyrifos (an organophosphate pesticide used to kill a number of pests including insects and worms); imazalil (a fungicide); imidacloprid (an insecticide); thiabendazole (a fungicide and parasiticide); and iprodione (a fungicide and nematicide].
- A number of scenarios were completed to account for short term (acute) and longer term (chronic) intake of pesticide residues. The exposure estimates of the acute and chronic assessments were expressed as a percentage of the relevant health-based guidance value, the Acute Reference Dose (ARfD) and the Acceptable Daily Intake (ADI) respectively. Acute dietary exposure assessments were completed for four pesticides with an established ARfD: chlorpyrifos, imazalil, imidacloprid and thiabendazole. In addition to these four pesticides, chronic dietary exposure assessments were also completed for iprodione (iprodione does not have an agreed established ARfD). All results were expressed on a per kilogram body weight basis.
- The results from the assessment scenarios are described below, with refinements between the scenarios described briefly here. In total, four scenarios were completed, two for acute intakes and two for chronic intakes. For both acute and chronic intakes, one assessment was more refined in nature and accounted for processing factors (i.e. peeling vegetables) and the variability that can occur when measuring pesticide residues in composites or batch samples of foods (Tier 2) - the other assessment did not make any such account (Tier 1). Further, acute (tier 2) and chronic (tier 1 and 2) assessments accounted for analytical non-detects (i.e. by either attributing '0' to values below limit of quantification (LOQ)(lower bound LB) or the actual numerical value of the LOQ (upper bound UB).
- Tier 1: conservative screening assessments which involve worst-case assumptions and tend to overestimate actual consumer exposure:
  - For acute dietary exposure assessments, a point-estimate approach was adopted using the equations of the International Estimation of Short Term intake (IESTI) (FAO 2009), but accounting for relevant processing concentration data which was available for some processed foods.
  - For chronic dietary exposure assessments, each individual's mean consumption was multiplied by the mean residue concentration for the relevant commodity.
- Tier 2: Refined, more realistic, assessments incorporating more sophisticated methods and using chemical processing factors
  - For acute dietary exposure assessments, simple distributions were completed using the computer software, DaDiet®, accounting for processing factors and the variability of residue concentrations between units in composite samples.

- For chronic dietary exposure assessments, this was calculated using the same method as the Tier 1 chronic dietary exposure assessment above but accounting for processing factors to give a more realistic estimate of exposure.
- The food sources contributing most to residue intake were identified.

### 3. Research Achievements/Results

- The first achievement of this project was the development of an Irish Food Conversion Model (IFCM) which first involved the identification and quantification of all ingredients present in a food as consumed and secondly converted the consumption data from both surveys to the edible forms of their respective raw agricultural commodities (e-RACs). This is the most comprehensive food ingredient database developed to date. It can be used to estimate intakes of food ingredients and it can be further utilised to aid disaggregation of any future national food surveys.
- The top ten raw agricultural commodities consumed by children and adults were water, milk cattle (i.e. cow's milk), sugar beet roots, potatoes, wheat, apples, barley, poultry muscle, oranges, grapes.
- For Irish Pre-school children, conservative Tier 1 acute and chronic assessments revealed some cases in exceedance of the relevant health based guidance values (the ARfD and ADI respectively). However, refinements introduced during the Tier 2 analysis resulted in exposure estimates that were not of concern and typically well below the relevant thresholds.
- The highest intake estimates during Tier 2 chronic exposure (Upper bound) estimates were for the organophosphate chlorpyrifos for both adults and pre-school children at between 3 – 33% and 11 – 100% of the ADI respectively. However, examination of this marginal exceedance for pre-school children revealed the exceedance was most likely due to the estimate model used, specifically the use of the LOQ in this UB estimate in any instance where cow's milk was consumed. In the preschool survey, unsurprisingly 100% of children consumed milk making it a commonly consumed food. In contrast, chlorpyrifos was not detected in any of the cow's milk samples tested resulting in the application of the LOQ in any UB assessments. The use of the LOQ for this frequently consumed food is the most likely reason for this marginal exceedance. Actual exposure levels can be expected to lie between the estimates calculated within the LB and UB scenarios i.e. 11-100%. Of further note, the health based guidance values for chlorpyrifos were lowered in 2014 and not yet in place when the monitoring data on pesticide concentrations in foods were completed so it is likely that actual exposure now is reduced further.
- Oranges were the commodity contributing most to chronic dietary exposure of chlorpyrifos and imazalial for both adults and preschool children.
- In conclusion, the application of refined methodologies revealed no health risk for Irish consumers to the five most commonly detected pesticide residues analysed in the Irish national control programme.

#### **4. Impact of the Research**

The project was carried out by an experienced multi-disciplinary research team with strong links to related ongoing research in food and health sciences. The research builds on and further develops existing collaborations in the areas of the food and health sciences that strengthens Ireland's capability in this area and maintains Ireland's position at the forefront of research on food consumption and health in the EU.

This research has also resulted in specialized training for researchers and has enhanced the pool of scientific expertise available to the Irish Food Industry and agencies involved in food and health policy development and regulation.

Findings from this research provide an important base of scientific knowledge to address food safety issues of relevance to development and implementation of public health policy.

##### Regulatory authorities and policy makers

This research underpins Ireland's capacity to satisfy the implementation of EU legislation on pesticide residues. It informs Ireland's annual contribution to Article 30.2 of EC Regulation 396/2005 ('Multi Annual National Control Plan for Pesticide Residues). Further the data generated are compatible with requirements of EFSA's 'Dietary and Chemical Monitoring unit' ensuring that Irish data can feed directly into relevant EU assessments on food chemical intake. Availability of this data to regulatory authorities and policy makers helps to ensure that policy development for food safety and nutrition at national and EU level is strongly evidence-based and protective of public health and reflects national needs but is not unnecessarily restrictive for industry.

##### The food industry

The project PIs and researchers have ongoing active engagement with the food industry and provide relevant data from the national food consumption surveys to support the needs of food companies (e.g. Kelloggs, Danone, Nestle, CPW), food industry bodies (FDII, Nutrition and Health Foundation, National Dairy Council, Beverage Council of Ireland, The Irish Bread Bakers Association (IBBA), IDACE - European Dietetic Food Industry Association, ILSI Europe), Food for Health Ireland and Meat Technology Ireland.

The data generated in this project help industry in assuring consumer health protection by providing for assurance for the safety of food. It can also be used to underpin development and international competitiveness of the food industry by attention to food safety issues, specifically intake of pesticide residues.

##### Consumers

The completion of this safety assessment of food chemical intake assures consumers regarding the safety of their food supply with respect to pesticide residues. It can also be used to further develop and implement public health policy to safeguard consumer health.

##### The scientific community,

The research has made an important contribution to scientific knowledge in this field, specifically with the establishment of the Irish Food Conversion Model. For this model, it was agreed at the project start that rather than focusing only on key food groups, all foods and recipes consumed would be disaggregated to an ingredient level. The resulting resource is extremely detailed whereby 2708 food codes in the adults survey and 1708 in the preschool survey were disaggregated to ingredient level. In one example, margherita pizza has been disaggregated to account for all ingredients in the dough, in the sauce and the toppings resulting in 16 distinct ingredients. The resulting database is a highly comprehensive resource which will allow calculation of intakes of pesticide residues and indeed a number of other food ingredients and chemicals in future research projects. The methodology has been presented at a scientific conference and in the associated conference abstract (See 4b).

#### **4(a) Summary of Research Outcomes**

##### **(i) Collaborative links developed during this research**

The PIs and researchers involved in this research have developed new collaborative links and strengthened existing ones in both regulatory authorities and in academia. These links include the Food Safety Authority of Ireland, the Pesticide Control Services Unit at the Department of Agriculture, Food and the Marine and in the European Food Safety Authority. Academic partnerships were developed with a Dutch research group who are at the forefront of estimating intakes of pesticide residues in Europe (Prof. Jacob van Klaveren, RIVM) and led to an invitation to attend a training event in Holland on software to estimate pesticide residue intake. Partnerships were also developed with EFSA resulting in an invitation to attend EFSA headquarters in Parma and to present the Irish Food Conversion Model generated to a technical working group.

##### **(ii) Outcomes where new products, technologies and processes were developed and/or adopted**

This research project has further developed the IUNA databases. This project has resulted in further development and exploitation of the state-of-the-art national databases of food consumption in adults and preschool children. The development of the Irish Food Conversion Model and disaggregation of each food consumed to its raw ingredient allows Irish policy makers to conduct their annual intake assessments of pesticide residues. This is the first time such data is available for Irish preschool children.

New technologies used included using probabilistic modelling software (Dazult©, Kildare) to conduct a comprehensive estimate of consumption of pesticide residues.

##### **(iii) Outcomes with economic potential**

The detail collected in the Irish Food Conversion Model allows for precise estimates of intake of foods at ingredient level and could be used for future impact assessments for reformulation of key ingredients e.g. sugar or salt or for more accurate estimates of intake of food chemicals.

(iv) Outcomes with national/ policy/social/environmental potential

This research underpins Ireland's capacity to satisfy the implementation of EU legislation on pesticide residues. It informs Ireland's annual contribution to Article 30.2 of EC Regulation 396/2005 ('Multi Annual National Control Plan for Pesticide Residues). Further the data generated are compatible with requirements of EFSA's 'Dietary and Chemical Monitoring unit' ensuring that Irish data can feed directly into relevant EU assessments on food chemical intake. Availability of this data to regulatory authorities and policy makers helps to ensure that policy development for food safety and nutrition at national and EU level is strongly evidence-based and protective of public health and reflects national needs but is not unnecessarily restrictive for industry.

**4 (b) Summary of Research Outputs**

(i) Peer-reviewed publications, International Journal/Book chapters.

Le Jeune J *et al.* Dietary exposure of Irish adults and pre-school children to commonly detected pesticide residues on the Irish food market. (In preparation)

(ii) Popular non-scientific publications and abstracts including those presented at conferences

- Nutrition Society Postgraduate Meeting, Cork (Title: 'Estimation of pesticide residue intakes in the Irish population'; Date: 12th February 2016).

(iii) National Report

(iv) Workshops/seminars at which results were presented

- EFSA 16th Food Enzymes Working Group Meeting & EFSA Evidence Management Unit Meeting; Parma, Italy. (Title: 'Development of an Irish Food Conversion Model'; Date: 19th May 2016).
- Pesticide Control Services Unit, DAFM Backweston. (Title 'Disaggregation of food consumption databases to raw agricultural commodity values for estimation of intakes of pesticide residues'; Date March 2017).

(v) Intellectual Property applications/licences/patents

(vi) Other

- 21-22<sup>nd</sup> March 2016 Euromix Risk Benefit Training, RIVM, Bilthoven, The Netherlands

## 5. Scientists trained by Project

Total Number of PhD theses:   0  

Total Number of Masters theses:   1  

Le Jeune J (January, 2017) Conversion of Irish national consumption data to raw agricultural commodity values to facilitate the estimation of dietary exposure to pesticide residues. University College Dublin

## 6. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (person years)
UCD	3	0.060
UCC	1	0.020
<b>Total</b>	<b>5</b>	<b>0.080</b>

## 7. Researchers Funded by DAFM

Type of Researcher	Number	Total Time contribution (person years)
Post Doctorates/Contract Researchers		
PhD students		
Masters students	1	2.0
Temporary researchers		
Other		
<b>Total</b>	<b>1</b>	<b>2.0</b>

## 8. Involvement in Agri Food Graduate Development Programme

Name of Postgraduate / contract researcher	Names and Dates of modules attended
N/A	

## 9. Project Expenditure

Total expenditure of the project: € 62,187.73

Total Award by DAFM: €66,000.00

Other sources of funding including benefit in kind and/or cash contribution(specify): € Nil

### Breakdown of Total Expenditure

Category	UCD	UCC	Name Institution 3	Name Institution 4	Total
Contract staff	0	0			0
Temporary staff	0	0			0
Post doctorates	0	0			0
Post graduates	43,999.48	0			43,999.48
Consumables	1,200.95	0			1,200.95
Travel and subsistence	1,290.68	726.38			2,017.06
Sub total	46,491.11	726.38			47,217.49
Durable equipment	841.31	0			841.31
Other	0	0			0
Overheads	11,622.78	181.60			11,804.38
<b>Total</b>	<b>58,955.20</b>	<b>907.98</b>			<b>59,863.17</b>

## 10. Leveraging

It is intended to use the comprehensive databases generated to secure further funding with respect to intake of pesticide residues and food ingredients nationally and internationally.

## 11. Future Strategies

Future strategies will involve further development, updating and exploiting of these new interrelated datasets which are derived from the Irish national food consumption databases. The current research builds on and further develops existing collaborations in the area of the food and food safety. The database established at food ingredient level (Irish Food Conversion Model) and associated estimates of pesticide residue intake provide scientific data to risk policy makers satisfy national and EU requirements for assessing the safety of intakes of food contaminants such as pesticide residues. It also ensures Irish data feeds directly in to any pan-

EU harmonised assessments completed by EFSA as the data generated are compatible with requirements of EFSA's 'Dietary and Chemical Monitoring unit'. Hence, the datasets generated will directly support the activities of a range of stakeholders e.g. the Food Safety Authority of Ireland, the Pesticides Control Services Unit of the Department of Agriculture, Food and The Marine and the European Food Safety Authority. This research programme has helped position Ireland at the forefront of research on food contaminants (e.g. pesticide residues) and health in the EU and will be used to develop the capacity of Irish researchers to participate in JPI and other funding streams e.g. Horizon 2020, Food 2030.