

# Estimations of plant protection products (PPP) input and environmental distribution in national and European level

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## Summery

### SPRINT project

The main output of the SPRINT project is development, test, validation and delivering a Global Health Risk Assessment Toolbox for the integrated assessment of the impacts of PPP on ecosystem, plant, animal and human health. The project is divided to different parts and main responsibilities of the RECETOX are: Health impact assessment, creating maps, toolbox development, and data mining for upscaling.

### Previous achievements

All available data from published monitoring studies on currently used pesticides (CUPs) in agricultural soils done around the world, were collected. All the data were harmonized and integrated into a united data set summarizing the overall situation for 387 individual active substances (AS) including 106 transformation products and 281 parental compounds. Moreover, an overall meta-analysis on the prepared data set was performed showing the situation of the CUPs in the soil of different regions and countries. This data set and the result of meta-analysis (which were also presented in previous annual conference 2021) are now available online<sup>1</sup>.

### Ongoing

the main goal in the next stage of the project, is **modelling the PPP input to the environment** (i.e. emissions - e.g. PPP usage data) and **preparation of the maps** which visualize predicted PPP input to the environment (generalized PPP application patterns) and modelled PPP concentrations in the environmental compartments (soil-water-air) in the national and EU level. The concentrations in the various compartments of the environment will be used for the exposure assessment and the exposure outputs will be compared with the hazard data to map the risk for each substance for terrestrial and aquatic ecosystems, animals, and humans. Environmental exposure will be complemented by **dietary exposure** assessment using additional data on feed and food from existing databases.

## Data collection

### Modelling the PPP input to the environment

The required data for the purpose of modeling PPP input to the environment are PPP usage data (active substance and crop specific) for given geographical areas, PPP application data (rate, composition, BBCH...), spatial and temporal crop data for given geographical areas, PPP properties database and other relevant data such as meteorological, pedological etc. which must be collected from the countries. Because not all the countries have comprehensive and detailed enough information on abovementioned requirements the main focus has been primarily given to the data-rich countries. Netherlands, and Czech Republic are among those countries with very detailed databases on PPP application and usage. For Czech Republic data were collected from Central Institute for Supervising and Testing in Agriculture (UKZUZ). The data, which has been assembled in the form of database, consist of several tables connected to each other. The database structure is given in the Fig 1. The following information can be extracted from the Czech database (POR) several SQL coding had been utilized to retrieved different information out of the database. One example of SQL coding were presented in Fig 2:

- the list of authorized formulated PPPs,
- the AS content in the PPP product,
- the type of pesticide,
- the application rates with the units (e.g., kg/ha),
- the application regime (way, intervals, times, crops, pests, BBCH)
- pre-harvest intervals,
- the approval decision & the decision owners,
- the authorization holders,
- the validity date of the decision of approval and trading,
- the date of the end of trading,
- the date of the start/end of approval,
- buffer zones and/or drift reduction...

During the last months, negotiations has been made for collecting the data from authorities of several EU countries, some successful and some others still needing more effort.

### Human dietary exposure to PPPs

In cooperation with Institute for Risk Assessment Sciences (IRAS), Utrecht University, the study on dietary exposure of human to PPPs has been conducted. The required data are food basket, daily consumption of commodities, and PPP residues in the commodities for each country since 2010. The data for food basket and food consumption were obtained according to the raw primary commodity (RPC) model<sup>2</sup> (Table 1).

The data for PPP residues were collected from the annual control program obliged by European Commission to its Member States according to Regulation (EC) No 396/2005. The data are reported separately for each year and country in huge tables containing several thousands of reports since 2011. Taking advantage of R Programing, we were able to harmonize and merge all the data to one larger databases for each year containing all available reports (Fig 3).

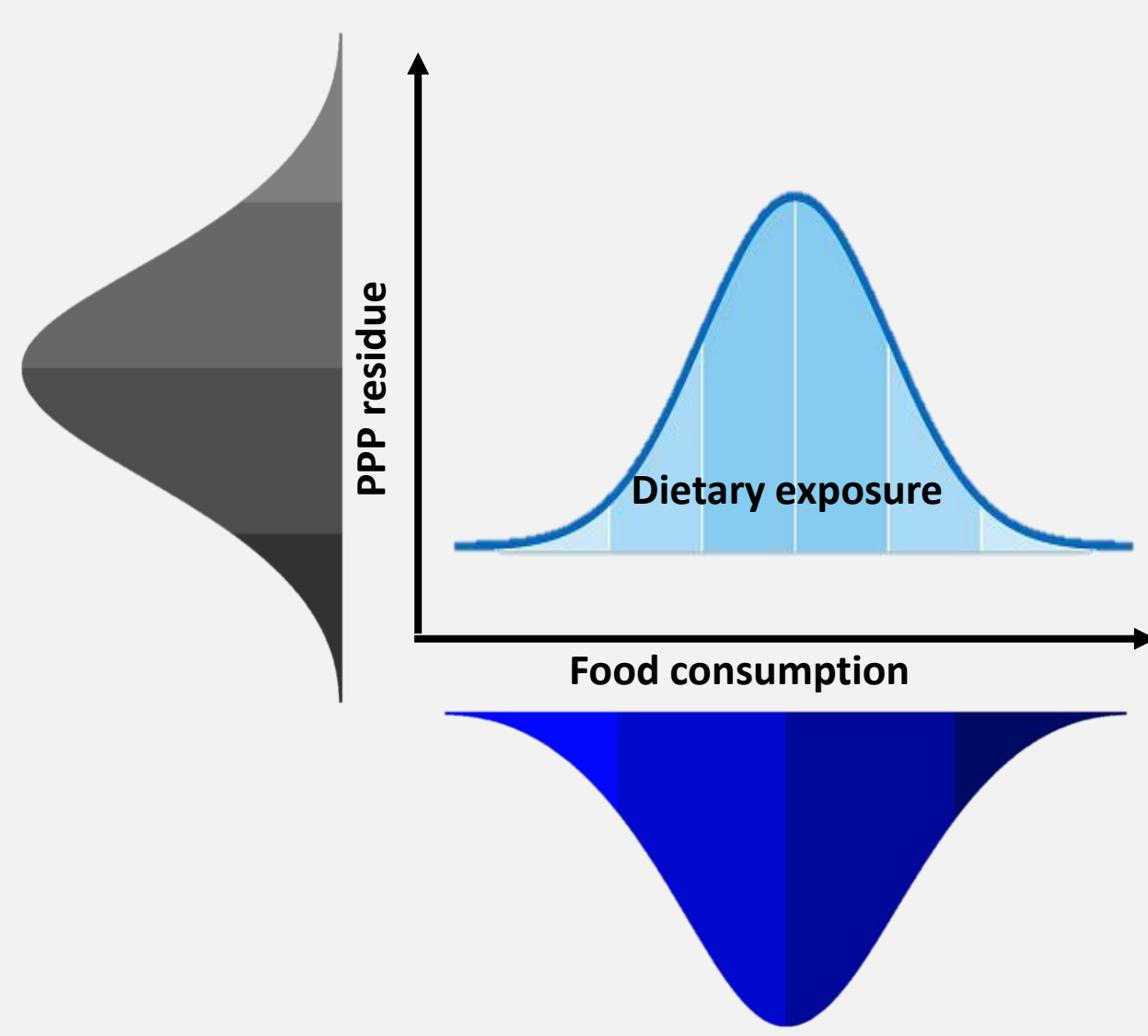
## Future steps

### Dietary exposure calculation:

According to a simplified equation dietary exposure can be calculated as follow:

$$\text{Dietary exposure} = \frac{\sum(\text{residue concentration} \times \text{food consumption})}{\text{body weight}}$$

In this study, in addition to exposure calculation over mean value of the Residue concentrations and food consumption, the distribution over dietary exposure will also be calculated. This distribution gives very precious additional information like the percentage of population exposed to a certain amounts of specific AS in national and EU level.



### Dietary exposure map preparation

After exposure calculation, the data will be merged to their geospatial coordinates and related maps showing the information about dietary exposure of the population of each country to PPP residues will be created. Moreover, the exposure maps for the whole Europe will be created for each individual AS.

### Modelling of PPP input into the environment and map preparation:

In parallel, using the national data on PPP's usage, sale, and crop types related to the application location, etc., the PPP's input into the environment will be modeled and accordingly visualized report in the form of maps will be prepared in the next upcoming year.

## References

- Sabzevari, S., Hofman, J., 2022. A worldwide review of currently used pesticides' monitoring in agricultural soils. Sci. Total Environ. 812, 152344. <https://doi.org/10.1016/j.scitotenv.2021.152344>
- Dujardin, B., Kirwan, L., 2019. The raw primary commodity (RPC) model: strengthening EFSA's capacity to assess dietary exposure at different levels of the food chain, from raw primary commodities to foods as consumed. EFSA Support. Publ. 16. <https://doi.org/10.2903/sp.efsa.2019.EN-1532>

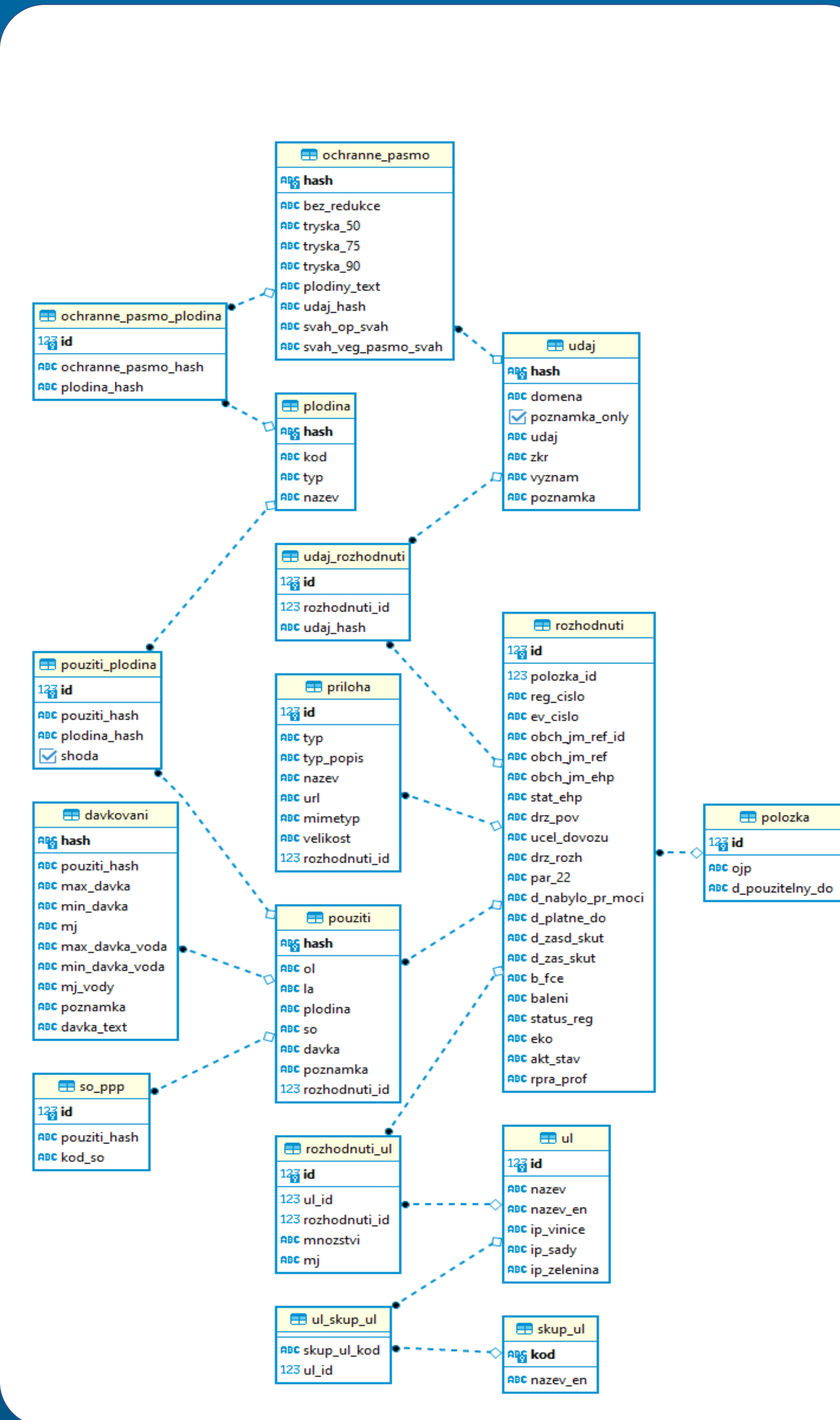


Fig 1. Structure of the POR database

```
SELECT *
FROM
zb_stg_por.stg_decision deci
LEFT JOIN zb_stg_por.stg_ppp ppp ON ppp.id = deci.id_ppp
LEFT JOIN zb_stg_por.stg_decision_as das ON deci.id = das.dec_id
LEFT JOIN zb_stg_por.stg_active_subs asu ON das.act_substance_id = asu.id

WHERE
name_en LIKE ('%Metazachlor%')
AND deci.reg_number NOT LIKE ('%X%') AND deci.reg_number NOT LIKE ('%V%')
AND (deci.dec_valid_till ::date BETWEEN '2020-01-01' AND '2020-12-31'
OR deci.dec_valid_from ::date BETWEEN '2020-01-01' AND '2020-12-31'
OR (deci.dec_valid_from ::date < '2020-01-01' AND deci.dec_valid_till ::date > '2020-12-31'))

order by
deci.id;
```

Fig 2. Codes needed to extract all PPP containing metazachlor which were allowed for use in any time window within year 2020

```
yourpath <- file.path(getwd())
# vector with years of interest
years <- c("2011","2012","2013","2014","2015","2016","2017","2018","2019","2020")

# define path
path <- file.path(getwd())

# vector of countries inside path
countriesnam <- as.vector(dir(path))

# loop for each year
for (i in 1:length(years)){
  dir.create(years[i])
  pathyear <- file.path(paste0(path,"/",years[i]))
  for (j in 1:length(countriesnam)){
    path <- file.path(paste0(path,"/",countriesnam[j]))
    v.filename <- list.files(path, pattern="\\.(csv|txt)$",
                           ignore.case = TRUE,
                           full.names = FALSE)
    for (k in 1:length(v.filename)){
      if(grepl(years[i], v.filename[k], fixed = TRUE) == "TRUE")
        {filescv <- v.filename[k]}
    }
    pathsource <- file.path(paste0(path,"/",filescv))
    file.copy(from = pathsource,
             to = pathyear)
  }
}
```

Fig 3. Example codes needed to merge all PPP residue reports available for each year

Country	Survey	publrefid	Food name (level 1)	Food name (level 2)	Food name (level 3)	Food name (level 4)	Subjects (id)	Consumers (id)	Mung (g/ds)	SD (g)	Medians (g/ds)	75th Pct (g/ds)	90th Pct (g/ds)	95th Pct (g/ds)	97.5th Pct (g/ds)	99th Pct (g/ds)
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Lettuces and salad plar	Lamb's lettuces and simil	308	6.17	1.13	4.87	0.00	0.00	11.25	17.50	30.00	30.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Lettuces and salad plar	Lettuces and similar	308	22.08	6.25	13.10	0.00	0.00	24.90	37.80	49.05	49.80
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Lettuces and salad plar	Lettuces and similar	308	29.55	6.87	12.70	0.00	10.00	20.00	37.50	41.25	60.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Lettuces and salad plar	Escaroles and similar	308	23.05	3.32	7.71	0.00	0.00	14.46	19.62	20.00	32.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Lettuces and salad plar	Roman rocket and similal	308	1.95	0.29	2.33	0.00	0.00	0.00	0.00	10.00	10.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Spinach-type leaves	Spinaches and similar	308	36.04	3.58	14.10	0.00	2.84	6.08	8.77	41.33	52.32
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Other leafy vegetables	Watercresses and similal	308	0.32	0.02	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Head brassica	Brussels sprouts and sim	308	0.32	0.21	3.73	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Head brassica	Head cabbages and simil	308	15.91	8.95	25.23	0.00	0.00	37.50	74.00	83.00	103.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Leafy brassica	Chinese cabbages and si	308	2.27	0.49	3.44	0.00	0.00	0.00	0.00	0.00	20.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Leafy vegetables	Leafy brassica	Kales and similar	308	1.62	0.14	1.14	0.00	0.00	0.00	0.00	0.00	6.32
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Sprouts, shoots and sin	Cresses	Cresses	308	0.32	0.03	0.59	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Sprouts, shoots and sin	Mung bean sprouts	Mung bean sprouts	308	0.65	0.15	1.91	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Flowering brassica	Broccoli and similar	Broccoli	308	6.17	2.16	10.81	0.00	0.00	0.00	7.87	39.00	65.50
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Flowering brassica	Cauliflowers and similal	Cauliflowers	308	12.66	3.19	12.83	0.00	0.00	9.72	19.65	28.80	65.50
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Asparagus and similar	Asparagus	308	1.30	0.69	6.32	0.00	0.00	0.00	0.00	0.00	25.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Celeries and similar	Celeries	308	35.71	1.27	5.98	0.00	0.97	3.33	4.45	5.20	7.66
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Globe artichokes and	Globe artichokes	308	0.23	0.14	2.45	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Leeks and similar	Leeks	308	9.42	0.94	4.85	0.00	0.00	0.00	0.46	10.00	25.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Rhubarbs and similar	Rhubarbs	308	0.32	0.16	2.85	0.00	0.00	0.00	0.00	0.00	0.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Bamboo shoots and sin	Bamboo shoots	308	2.27	0.13	0.87	0.00	0.00	0.00	0.00	0.00	6.55
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Stems/stalks eaten as	Kohlrabies and similar	Kohlrabies	308	1.30	0.81	8.63	0.00	0.00	0.00	0.00	0.00	15.00
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Bulb vegetables	Garlic and similar	Garlic	308	77.60	0.88	1.17	0.44	1.10	2.49	3.49	4.29	5.69
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Bulb vegetables	Onions and similar	Onions	308	74.68	8.81	11.27	5.46	12.50	25.00	31.09	39.80	45.98
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Bulb vegetables	Shallots and similar	Shallots	308	2.27	0.54	3.87	0.00	0.00	0.00	0.00	0.00	16.10
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Bulb vegetables	Spring onions and simil	Spring onions	308	43.18	3.97	6.24	0.00	6.55	12.59	16.37	20.77	26.43
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Legumes with pod	Beans (with pods) and	Beans (with pods) and	308	13.64	2.34	7.39	0.00	0.00	7.14	17.69	26.00	27.28
Austria	ASNS - ADULTS	Adults	Vegetables and vegetable	Legumes with pod	Peas (with pods) and s	Peas (with pods) and s	308	0.97	0.05	0.56	0.00	0.00	0.00	0.00	0.00	0.00

Table 1: A snapshot of the output table of raw primary commodity (RPC) model for food basket and food consumption