Reducing Food Waste -
Identification of causes and courses of action in North Rhine-Westphalia

Abridged Version

Study for the Round Table „Neue Wertschätzung von Lebensmitteln“ - „New appreciation of foods“
of the Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer
Protection of the German State of North Rhine-Westphalia

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Authors:

University of Applied Sciences Münster
Institute for Sustainable Nutrition and Food Production – iSuN

Research-module A: Qualitative analysis of the causes of food waste and project coordination of the complete study
M.Sc. Oec. troph. Christine Göbel
Prof. Dr. Petra Teitscheid
Prof. Dr. Guido Ritter
Dipl.-Oecotroph. Antonia Blumenthal
B.Sc. Oecotroph. Silke Friedrich
B.Sc. Ökotroph. Tanja Frick
B.Sc. Ökotroph. Lisa Grotstollen
B.Sc. Oecotroph. Carolin Möllenbeck
B.Sc. Oecotroph. Lena Rottstegge
B.Sc. cand. Cynthia Pfeiffer

Research-module C: Investigation of statistic amounts of food waste and recycling methods
M.Eng. Daniel Baumkötter
Prof. Dr. Christof Wetter
B.Eng. cand. Britta Uekötter

Consumer advice center (Verbraucherzentrale) Nordrhein-Westfalen

Research-module B: Survey amongst private households
Dipl.-Ing. agr. Bernhard Burdick
Dipl.-Ing. agr. Nina Langen

Trifolium - Beratungsgesellschaft mbH

Shorty study in research-module D: Consumption of resources and environmental impact within the upstream chain of food waste
M.Sc. Michael Lettenmeier
Dipl.-Ing. Holger Rohn

Contents of the study on hand are equally applicable to males and females. To ensure better readability, the author has chosen to refer to people in the male form only.
„The great value of small morsels: I remember my grandfather well, and how he used to sit at the table with us during family celebrations. When he had done eating, he started to collect the breadcrumbs that had fallen onto the tablecloth. He would form a bowl with his hand, put every single crumb inside one by one, and at last take his hand to his mouth.“

Carlo Petrini, founder and international chairman of Slow Food

„The time has come to not understand abstinence as a limitation and an inconvenience, but as a chance and the possibility to inspire creativity and curiosity.
We have to exercise how to manage with less, to consume less and to thereby raise our quality of life.“

From Wolfgang Schmidbauer, author of „Homo consumens“ in Welt am Sonntag No. 8 – 19. February 2012
Preface by the editor

Humans have always assigned a lot of meaning to their food, since it does not only serve to provide essential nourishment: Food is closely linked to cultural identity and social belonging and they serve as indicators for an individual's status in society. Notwithstanding the high importance of foods, appreciation of and attitude towards them have changed dramatically within the last decades. Especially within rich countries. Households have freed themselves from the burdens of cooking, conserving and storing. These tasks have been passed on to the food industry. Agrarian policy has set its course on mass production and the discount strategy of big business groups has led to deterioration on food prices, especially in Germany. It seems that things came out even: Today, it takes a lot less time to earn the money needed to buy food, than the time self-sufficiency consumed back in the day. On top of that, there has been a superabundance of food within Europe for the past decades.

But this paradisiacal situation comes with a price: We may have a high standard supply of standardized, safe, ready-to-eat, ever-available food. But on the other hand, obesity, nutrition-related diseases, the decreasing ability to indulge, a growing separation from initial production and the loss of nutritional knowledge advance. The appreciation for food has decreased tremendously.

We experience an abundance of food while at the same time we appreciate it so little – both of these feelings are important causes for the massive amounts of food waste that is being created by Germans. There is no inhibition threshold for discarding food any more. Whenever quality standards, optical standards or the standardized tastes we wish for are not being met, products get thrown away. Up until the years after World War II, every single calorie was of importance for the people in Germany. Every item, that held only the smallest value to the food chain, was put to use: The food itself was prepared and consumed, bones were boiled out, the little amount of scraps such as shells, peel or cuts were fed to the livestock. If people produced more than they needed, this surplus would be conserved through pickling or canning.

Today, the question of whether it makes sense to keep any leftover foods is hardly asked any more at all. But on the other hand, new forms of appreciation for food appear: Items that are perceived as especially authentic, very healthy or extremely exotic are usually of a higher (monetary) value to the customer and are also chosen with special diligence. The ideas of social and ecological sustainability are becoming more important and have a growing influence on consumers and their nutritional choices.

This new, conscious view on foods has led to a situation in which journalists and public are aware of the enormous amounts of food waste we create today. Especially the disposal of edible and perfectly fine foods has come under criticism: Movies, documentaries and newspapers have picked up the topic and shown its explosiveness. By now, the discussion has been taken up by politicians who have perceived the need for action. On a regional, as well as on a national and international level, the reduction of food waste has been put on the political agenda. Yet, it is important to remember that a change towards higher appreciation can only start...
locally within the boundaries of daily life and
every day choices.
The reward for this kind of effort is nothing
less than an increased pleasure in eating and
an overall higher quality of life.

Prof. Dr. Guido Ritter

Prof. Dr. Petra Teitscheid

Prof Dr. Christof Wetter
Abstract

The research project „Reducing Food Waste – Identification of causes and courses of action in the German State of North Rhine-Westphalia“ („Verringerung von Lebensmittelabfällen – Identifikation von Ursachen und Handlungsoptionen in Nordrhein-Westfalen“) (time-frame: 9/2011 – 2/2012) is connected to the discussion on a new appreciation of food and a sustainable lifestyle. The Institute of Sustainable Nutrition and Food Production (iSuN) of the Münster University of Applied Sciences and the Consumer Center of North Rhine-Westphalia the task of conducting a study, focused on the identification of causes of food waste and possible courses of action in North Rhine-Westphalia. This task was issued by the Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection (MKUNLV).

The food market operates highly globalized and works based on a division of labor and the North Rhine-Westphalian situation does not differ much from the German or European situation. Orientation towards North Rhine-Westphalia within the study was achieved by the choice of interview partners and business experts. This orientation was further supported through the choice of the locally relevant product groups vegetables, bread and bakery, milk and milk products as well as meat and sausage products. Courses of action for a reduction of food waste in North Rhine-Westphalia can possibly be transferred to other German federal states.

The study consists of four research-modules. Research-module A analyzes the causes of food waste within the four relevant product groups and deduces the implicit possibilities for procedure recommendations. The analysis of causes is based on the value chain of the specified product group, from agriculture to retail. The potential arrays of causes show that practices which lead to food waste often take effect across various levels of the value chain. Therefore it is important to take the interfaces between levels into account, in order to develop practical measures that decrease creation of food waste. The analysis of face-to-face interviews and anonymous online-interviews in private households was performed in Research-module B. Therein, reasons for the wasting of food through consumers were detected and based on the findings and recommendations to reduce food waste are made. The interviews show that, especially, the complex and unpredictable lifestyles and job-situations lead to the littering of food. Research-module C analyzes the available statistics, in order to gain data on the amount of food waste produced in North Rhine-Westphalia. Research-module D shows that the creation of food waste leads to considerable social, economic and ecologic effects. The dimensions of ecological effects of food waste are shown through an exemplary consideration of the consumption of resources and environmental effects of selected foods. The foods consume resources within the upstream chain, that amount to multiples of the waste that is later created through the wasting of these foods. Within foods from the four examined food groups, ecologic footprints divide differently from the way, the amount of waste created through them divides. This is due to the different amounts of resources that are used up per kilogram of each food. While vegetables and fruits are accountable for the
highest amount of food waste, their share of
the consumption of resources is lower than
that of meats.
Out of the four research-modules, the study
devises commendations on reducing food
waste in North Rhine-Westphalia within the
four categories „process enhancement/
interface management“, „structures and rules“, „Re-use/recovery instead of devaluation“ and „appreciation and enhancement“. Based on
these categories, practical approaches can be
developed for the participants of the round
table „new appreciation of food“ („Neue
Wertschätzung für Lebensmittel“) as well as
for North Rhine-Westphalian politics, in order
to avoid the creation of food waste and to find
new markets that can help to reduce
merchandise loss or to find subsequent uses
for discarded foods.
The research project „Reducing Food Waste – Identification of causes and courses of action in the German State of North Rhine-Westphalia“ („Verringerung von Lebensmittelabfällen – Identifikation von Ursachen und Handlungsoptionen in Nordrhein-Westfalen“) (timeframe: 9/2011 – 2/2012) is connected to the discussion on a new appreciation of foods and sustainable lifestyles. The Institute of Sustainable Nutrition and Food Production (iSuN) of the Münster University of Applied Sciences and the Consumer Center of North Rhine-Westphalia were given the task of conducting a study, focused on the identification of causes of food waste and possible courses of action in North Rhine-Westphalia. This task was issued by the Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection (MKUNLV). The study is concerned with the situation in North Rhine-Westphalia. This orientation was achieved by the choice of local interview partners and business experts and was further supported through the choice of the locally relevant product groups vegetables, bread and bakery, milk and milk products as well as meat and sausage products. Courses of action for a reduction of food waste in North Rhine-Westphalia can possibly be transferred to other German federal states.

Food Waste is a problem not only in ethical regards, but also for ecological, social and also economical reasons. The arising of food waste conflicts with the idea of sustainability as defined by the Brundtland-Comission in 1987. The goal of sustainable food safety was to be a mode of operation „that meets the needs of

the present generation without compromising the ability of future generation to meet their own needs“.

The wasting of edible foods has become an important political topic. The European Commission has set the goal of reducing the amount of discarded edible foods by half until 2020\(^1\) in the „Roadmap for a resource-efficient Europe“\(^2\). 2013 shall be made the European year for the fight against food waste, according to the parliament of the EU parliament\(^3\).

So far, there has not been any research on amounts, causes and sources of food waste in Germany. This is why there has been another study, focusing on the amounts of discarded foods in Germany, issued by the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) in 2011. The study presented in this paper has been initiated around the same time, but by the Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection (MKUNLV). The study’s focus is on the identification of causes and possible courses of action on the way to reducing of food waste. The Institute of Sustainable Nutrition and Food Production (iSuN) of the Münster University of Applied Sciences has been entrusted to conduct the study between September 2011 and February 2012 together with the consumer advice center of North Rhine-Westphalia. The results of the study shall be used as a base from which to derive

\(^2\) Roadmaps for a resource-efficient Europe.
suggestions on the reduction of food waste. These suggestions will aid political decision makers in North Rhine-Westphalia and participants of the round table ‘New appreciation of food’ with the development of practical measures on the minimization of food waste. The qualitative study presented in this paper is connected to a pan-European examination of food wastes.

The study is made up of four research-modules. In research-module A, four relevant local product groups of North Rhine-Westphalia (vegetables, bread and baked goods, milk and dairy as well as meat and sausage products) are analyzed for the amounts of food waste they create. Recommended actions are derived from the results. These may be applied to North Rhine-Westphalia and beyond. The North Rhine-Westphalian food market is connected to global markets, even beyond Europe – yet, concepts dealing with the minimization of food waste have to work locally. The value added chains are analyzed from farm to fork.

Research module B is focused on the reasons, consumers have for the wasting of food. Information is gathered through personal interviews and online interviews. Based on this information, recommendations are given.

Available statistical data that is related to the amounts of food waste that are created within North Rhine-Westphalia is analyzed in research module C.

Research module D deals with ecological, economical and social consequences of the creation of food waste. An exemplary examination of environmental impacts and resource consumption, with consideration of the upstream chains, tries to reveal the ecological impacts of food waste.

All research modules make use of the following definitions:

- **Food**: Everything that is suitable for human consumption by current state of the technology
- **Food Waste**: Everything that is not consumed by society for safety reasons, manufacturing processes, market conditions, ethical or cultural reasons or out of habit.
- **By-products**: Everything that is not recognized as a potential food in the western culture by current state of the art (shells, bones, stems...)

The results of the study can be summarized as follows:

**Research module A: Qualitative analysis of causes of food waste in four product groups** *(Institute of Sustainable Nutrition and Food Production, Münster University of Applied Sciences)*

The qualitative analysis was based on half-standardized, open Interviews with 44 experts from all stages of the value added chain of the product groups vegetables, bread and baked goods, milk and dairy and meat and sausage products. The transcripts were anonymized and evaluated through a qualitative content analysis, in order to identify causes of food waste and corresponding needs for action. All results were validated and developed in dialog with experts. For the vegetables product group, commission regulations as well as product specifications were identified as the main causes of food waste. Standardized packaging is an additional contributor to the problem of food waste in the vegetable sector. It became clear that with vegetables, direct marketing leads to less waste than other channels of distribution. This is due to the fact,
that less interfaces, quality checks, restrictions on quality and transports occur in direct marketing.

A central problem within the group of bread and baked goods is the limited freshness of the goods (especially with „ultra fresh goods“). It conflicts with the consumers wish for fresh products to be available until late in the evening.

With milk and dairy, many causes for the discarding of goods are linked to technical issues (for example wastage through defects of the machinery) or other deficiencies (such as losses due to cleaning of the machines or a change of flavor). The best-before date also has a big impact on sales, especially with foods from this group. Products that have come close to expiration will often be rejected.

The industrialized value added chain for products from the group of meat and sausage products is under a big pressure of time and costs. It is not economical to use labour or time just to reduce the amounts of waste.

Any deviations from product specifications regarding quality, optical characteristics, texture and temperature automatically lead to food waste, because foods from this product group hold high health risks.

Across all product groups, seven central potential arrays of causes were identified:

1. the definition of process- and market-induced standards and quality requirements
2. legal framework requirements; especially regulations to guarantee food safety
3. market conventions
4. human errors as well as
5. technical issues or
6. hold-ups within logistics and
7. cultural influences

An analysis of inter-dependencies shows, that causes and effects can be assigned to different stages of the value chain. Demands on products as well as the selection of goods create waste in stages that differ from the stage in which these demands are made. Product specifications and demands on quality on later value-added steps, especially with products from the vegetable group, cause food waste to get downshifted within the value chain (see figure: Causes and effects of food waste – process- and market-induced standards and quality requirements).

Causes and effects of food waste – process- and market-induced standards and quality requirements
The constant availability of fresh and diverse goods has become a central prerequisite in our markets – and leads to the creation of food waste in the early stages of the value added chain. Expectations on freshness, variety and availability as a cause of food waste and the effects resulting from it are shown in the figure: Causes and effects of food waste – market conventions (freshness, variety and availability).

The interviews clearly show, that the demands of consumers, or rather the consumer demands as expected by retailers, lead to food waste all along the value added chain. The interesting point is, that these demands do not influence the stage of the value chain, on which they are expressed: Problem and waste get shifted down to earlier stages. The dotted line between retailer and consumer represents the assumption, that the presentation of wares is able to influence the consumer and increase sales.

The most intensively discussed instrument used for quantity control is the expiration date, or best-before date. Interviews showed, that that expiration date and the remaining time to expiration, as requested by retailers, is not only used as an instrument of quality control anymore. Today, the expiration date is
employed as an organizational instrument. It influences quantity control and is used in marketing, too.

If used as an instrument of quantity control, the expiration date and the retailers requests associated with it are leading causes for food waste in different stages of the value chain (see figure: Causes and effects of food waste – the expiration date as an instrument of quantity control).

Analysis of the causes of food waste shows clearly, that there is not a single culprit that can be blamed for the current situation. It also makes clear, that a single solution will not be able to bring forth notable changes. It is of high importance, to inform all stakeholders of the food supply chain on this topic and to involve them in the approaches towards a reduction of food waste. Only by doing so, as few foods as possible will be discarded and the many causes of wastefulness within the different sectors of food industry can be eliminated. Courses of action for a reduction of food waste will be seen within the own company, but also in interaction with other stages of the value chain. Especially the interdependencies of the own company with the general framework, the interactions on the markets as well as with its social environment and with the appreciation of foods.

**Research module B: Interviews among private households on the waste of food (consumer advice center North Rhine-Westphalia)**

The consumer advice center North Rhine-Westphalia questioned 44 consumers in oral interviews that were based on a manual. They also examined the appreciation and handling of food of another 351 consumers. A standardized online interview was used for the latter. Interviews were conducted between October and December of 2011. Questions were based on the results of prior studies on the reasons for and the amounts of food waste in households, as well as on the commendations on reducing food waste in households that were given therein.

The interview was designed to measure the level of appreciation for food among consumers and to find the reasons behind the wasting of food. Buying behavior (frequency, planning, range of products, packaging sizes), handling of the expiration date and of leftover foods and scraps, the preparation of meals (portion sizes, frequency) and the storage of foods and meals were examined in order to gain the desired information.

The second aim was to evaluate the causes. In order to do so, problems with the fulfillment of shopping, storing and preparing were identified. Habits, instructional knowledge as well as perceived self-efficacy towards reality and the awareness of the problem were examined.

A third goal was the identification of courses of actions in a households/consumers everyday life. The examination analyzed acceptance, readiness, motivation, drivers, benefits as well as restraints and blockades, through the implementation of open and closed questions as part of the interviews.

The results of the interviews among households in North Rhine-Westphalia in the end of 2011 confirmed prior studies in some points, but showed a completely different picture in other points. Several finding are completely new.

The study shows, that food waste is not

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only generated differently within specific to
food groups, but that there are differing
reasons for food waste. Consumers named
trouble with the planning of meals for bigger
groups of people. This statement shows that
we are dealing with a hybrid consumer who
bases his decisions on the present situation. If
guests are expected, consumers tend to buy
more than they would during 'normal' shopping. The results at hand contradict the
Rheingold study⁵: It was shown, that most
buying decisions are made based on
requirements and that there is no optional
shopping (as found by the Rheingold study).

The interviews were not designed for the
measuring of exact amounts of leftovers in
households, but to deliver results that show
tendencies. Findings show, that bread is
wasted on a more frequent basis than fruit
and vegetables, and that the latter are wasted
more often than leftover foods. Meat, dairy
and cereal are thrown away rarely. These
results suggest that food which comes without
an expiration date is discarded more often
than products that are sold with a best-before
date or a use by date. These findings do not
correspond with the results of the Cofresco
study⁶, which found wasted baked goods to
rank nearly level with home-cooked meals
(both were found to be tossed rarely), and
which found fruit and vegetables to be the
most wasted food group, ranking clearly over
meats and dairy. In the interviews, many
consumers could give a reason when they
were asked for their motivation for discarding
bread, and a quarter of consumers could name
a reason for discarding fruit and vegetables.
18% of informants provided a motivation for
the waste of leftovers – but with meat, cereal
and dairy, only few people were able to name
reasons.

In order to determine the influence of
different factors on the wasting of food, a Logit
model⁷ was built. As the dependent variable, a
dummy variable was built. It indicates whether
one person more or less than the average will
toss the sampling. The following factors were
identified as influential: age-group (younger
persons tend to toss the sampling more often
than the average person), frequency of food
shopping (the more often people shop for
foods, the higher the probability of an above
average littering rate) as well as a factor that
indicates whether the person likes to eat out
or consume deep-frozen meals (the more a
person does so, the more likely he will waste
more food, too). The interviews also allowed a
detection of significant differences between
people’s ways of dealing with leftover foods.

Expiration dates, which have been
identified as influential by prior studies, got
interpreted correctly by most participants. This
goes for best-before dates (Mindesthaltbar-
keitsdatum in German, representing the date
until which the producer guarantees that his
product meets sensory quality standards) as
well as for use-by dates (German: Verbrauchs-
datum, indicating that a food possibly places a
health risk if consumed after the given date). A
Logit model was able to show that the younger
the informants were, the better was their
understanding of these dates. It also indicated,
that a better knowledge about the correct
storage of food correlated with a better
understanding of best-by and use-by dates.

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⁵ Vgl. Rheingold 2012
⁷ Logit model: An econometric, non linear model used
to explain binary dependent variables. A vector of
explaining variables influences the probability of the
event’s occurrence (Gabler http://wirtschaftslexikon.gabler.de/Definition/logit-
modell-fuer-binaere-daten.html).
People that like to eat out or consume a lot of deep-frozen meals, in short: people that do not enjoy cooking for themselves, had a lesser understanding of expiration dates. Based on these results, it is possible to conclude that the expiration date is not misunderstood, but simply used as an excuse for the discarding of products consumers dislike.

An ongoing discussion focuses on the minimization of food waste created by private households. Certain tips and ideas on how to reduce the amount of waste are named notably often. Examples for well used hints include the warning not to go and shop for food on a hungry stomach, to not buy unnecessary foods just because they are on sale and to always take a shopping list. This study by the consumer advice center North Rhine-Westphalia shows clearly, that consumers blame neither unnecessarily bought items nor shopping while hungry for the wasting of foods in their own household. Faulty planning was also found to be less relevant than the simple fact that people forget about foods they already have at home. Other important factors that contribute to the accumulation of food waste are improper storage and products that just did not meet the taste of the consumer.

Thin interviews show, that different consumer groups have special needs for information: While one group of informants said that they needed more information on how to store foods properly, others mentioned that they would like to know more about the consequences of food wastage and about the role consumers play in the creation of food waste. Online-recipe databases, homepages, YouTube videos or cooking parties were most interesting to younger people, with YouTube videos appealing especially well to men. A noteworthy finding is that young people do on the one hand waste food in above average amounts but on the other hand enjoy cooking in groups and take a big interest in cooking tips, cooking classes and multimedia-based offers on the topic of food waste. Younger consumers involve themselves in social media platforms and are more likely to become part of social movements. Therefore, a way of reducing food waste in younger households may be the implementation of the idea of food and food preparation as a fun and beneficial part of culture in younger people's minds. It may be helpful to keep in mind the insights on sentiment marketing (compare: Rheingold, 2012).

For the ultimate goal, the reduction of food waste, it may be of little effect to address consumers as parts of target groups that have been defined by the use of socio-economic criteria. Offers that address consumers only in certain situations will probably be more effective. If one of the main findings of the study at hand is, that many leftovers are created during parties, it may be important influence consumers, so that the topic of food waste will stay on their minds even at such occasions as festivities, and that they will come up with ideas for dealing with the leftovers (for example by dividing them up among guests or by finding ways of using the leftovers as a part of upcoming meals).

The results allow the conclusion that the kind and amount of food waste which is created within households depends on many different external and internal factors. It depends for example on the products that are available, the living environment, the needs, abilities and resources but also on the personal level of commitment. This is why a lot of different measures will have to be taken in
order to change all possible parameters and in doing so help to minimize food waste in private households. Possible short-term measures come to mind, but there is also a need for more extensive research in the long run.

Measures on a social level include the provision of information for consumers as well as the offering of trainings that may lead to a higher appreciations for food as well as inform participants about reasons for wastage of food and provide them with strategies in order to reduce food waste. According to the interview results, information which is released by the consumer advice center is highly sought after. It is therefore important that existing papers and educational offers are revised and advanced. The results of this study may serve as a base.

The two most pressing topics for further in-depth research are the exact quantification of food waste in private households and an analysis of motives and behavioral patterns relating to expiration dates. Another possible field of research may include a use of the findings of neuro- and sentiment marketing. With the help of these ideas, it may be possible to make the hybrid consumer understand the many dimensions of food waste in a way which will lead him to feel that the reduction of food waste is an ethically correct and meaningful goal.

Research module C: Quantities of trade-specific food waste and their ways of disposal, based on statistical data (Institute of Sustainable Nutrition and Food Production, Münster University of Applied Science)

Harvest statistics, crop loss quantities, slaughtering quantities, import and export data as well as statistics issued by organizations or companies were analyzed, in order to determine the amounts of food waste created by certain industry branches. The identification and appraisal of the ways of disposal of food was achieved through an analysis of waste statistics. Also the state of the art of the waste management was observed for the analysis. Only limited data on food waste is available, so that with some statistics researchers were forced to make assumptions as to whether the data on hand is about waste deriving from food or from animal feed.

Food flow and food waste in Germany 2009 (indicated percentages on food waste are based on the total amount of foods at the respective value-added step. Deviations from sums are due to rounding)
The results show that 13% of initial production end up as waste. This figure has to be understood as a minimum. Since the figures are statistically firm, it is improbable that the actual amount of food waste is lower than this rate. The data which is available up to now is insufficient in order to identify food waste. This is partly due to the fact that the specific amounts of food waste occurring in some branches along the value added chain are unknown as of yet. Statistics deliver only limited information. Especially for retail companies, no valid data has been published. Making these figures known, on the other hand, would help researchers to identify courses of action for each single branch and to define them more clearly, which would aid businesses with reducing food waste.

It will not be possible to totally eliminate food waste in the future. This is why waste has to be recycled in an optimal way. Thermal utilisation as well as material utilisation, for example as animal feed, has to be preferred to waste disposal. Only when it is impossible to put food waste to any other use, fermentation and subsequent composting or the fabrication of bio fuels should be an option. Using fermentation prior to the composting of waste has an advantage over direct composting: energetic and ecological potentials that have not been utilised up to now are used in the best possible way. “Technical upgrading of existing composting plants can be recommended unreservedly from an ecological point of view.”

Research module D: Ecological, economical and social effects of food waste (Institute for Sustainable Nutrition and Food Production and Trifolium Consulting - mbH)

This study is not extensive enough to systematically discuss the effects of the wasting of food for all three dimensions of sustainability: ecology, economy and equity. Yet, the authors want to at least take the study full circle and to spark a discussion on a resource-light, socially fair and sustainable way of living and managing. The authors also mean to give an impulse for a more extensive research on ecological valuation. A short study was conducted, which ecologically valued merchandise losses for certain exemplary foods. Losses within the upstream chain have been taken into account. Possible indicators for the valuation of ecological effects have been discussed. The consumption of resources of chosen foods as well as for the whole of food waste are assessed and the economical and social effects of food waste is discussed.

Short study - resource use and environmental impacts of food waste within the upstream chain (Trifolium Beratungsgesellschaft mbH (Trifolium Consulting))

The short study displays the relevance of upstream chains for food waste of seven exemplary food groups as well as for the general creation of food waste throughout Germany. Possible recommendations on actions for the consideration of the upstream chain during management and analysis of foods and food waste are given. The related material and carbon footprints are used as indicators. For the food groups examined throughout the
study, the annual waste accumulation per person lies between 0.5 kg for sausage products and 11 kg for bread. The material flow is unequally higher: The carbon footprint of wasted sausage products is 1.3 kg, the material footprint of wasted bread amounts to 61 kg. The waste created by German households has a material footprint of about 1.2 t a year per head. If these figures are extrapolated and applied to all of Germany, they represent the amount of resources needed to feed 15 million people. This equals the combined number of citizens of the German federal states of Lower Saxony, Schleswig-Holstein, Mecklenburg-West Pomerania, Hamburg and Bremen. The footprints within the upstream chains are divided among the product groups in a way which differs from the way, waste accumulation divides between them. Fruit and vegetables account for the highest amount of food waste (43 %). Their share of the total footprint created by the examined food groups is significantly lower than that, yet still relevantly high.

The upstream chain footprints of meat products as well as of dairy exhibit a relevance (49 % respectively 62 % altogether) which would not be expected from looking at their waste accumulation (22 %) alone.

It becomes clear, that the upstream chains of wasted foods have a high relevance with regard to the material flow associated with them. Product groups rank differently when sorted by the waste that is created within their upstream chains from the way they rank when sorted by the total amount of food waste they account for. This is why examination and management of food waste should always take into account indicators for utilisation of resources and other environmental impacts of related upstream chains.

Central fields of action to reduce food waste

In the context of the four research modules, the study recommends courses of action for reducing and avoiding food waste in North Rhine-Westphalia in the four categories: „process enhancement/interface management“, „structures and rules“, „Re-use/recovery instead of devaluation“ and „appreciation and enhancement“. These four fields of activity along with the results from the study at hand allow the development of practical courses of action. These ideas can serve as recommendations to the participants in the round table "new appreciation for food" as well as to politicians in North Rhine-
Westphalia and help in finding ways of reducing food waste and identifying ‘new markets’ for the subsequent use of food waste.

In the category „process enhancement/interface management‟, the problem of insufficient cooperation and cooperation across production stages leads to a lot of food waste. Today, foods are produced within a global network. Each single company that takes part in the production process will try to optimize their own processes but at the same time accept that their actions may lead to an accumulation of food waste in earlier stages (for example: less stock-keeping but at the same time demanding a permanent stock availability downshifts the risk of spoilage to an earlier stage of production). The study therefore recommends an optimization of value added chains, focused on waste avoidance.

The examination of commercial operational structures in the category „structures and rules‟ makes clear, that the rules which regulate food production lead to food waste which would usually be classified as avoidable waste. Product quality categories, standards etc. simplify the co-operation of partners in trade and serve as a method of quality control. At the same time, these standards and norms create a situation in which a product that does not fit in with standards cannot be put to its intended use. The study recommends a multi-stakeholder dialogue that critically deals with the use of and need for norms, rules, specifications, quality expectations and habits with particular regard to the reduction of food waste. The aspects of consumer protection and food safety have to be taken into account.

Causes for food waste are often linked to missing concepts for subsequent uses and or insufficiently utilised ways of disposal. These causes are named in the category „Re-use/recovery instead of devaluation‟. Food often gets wasted even though prospective buyers are available, often in close proximity. Biogenic waste is often simply composted, even though it would be more economical as well as more ecological to precede the process of composting with waste fermentation. Food waste can also be used for the production of bio fuels. The study recommends regional initiatives and model projects for an innovative waste management, focused on the re-use of waste. The development of supporting services and the development of composting plants towards an area-wide availability of fermentation facilities.

The category „appreciation and enhancement‟ lists causes for food waste that are rooted in the way consumers appreciate food, in the knowledge of foods and the ability of preparing or storing food. In order to minimize food waste linked to these causes, the study recommends informing and educating consumers on the topic of food waste. At the same time, innovations and services that focus on relieving consumers from some of their complex daily routines, because this will aid the consumer with the chance to better match and manage shopping, food preparation and consumption.
New appreciation for food – 4 central fields of action

Central fields of action of the reduction and prevention of food waste in North Rhine-Westphalia
Reference List


