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Food Traceability in Jordan

Current Perspectives

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On the following pages you will find the contents of the book and chapter 1 - An Introduction to Food Traceability

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Chapter 1
An Introduction to Food Traceability

Abstract This chapter concerns the evolution of food traceability matters in the current market of traditional foods and beverages. At present, traceability is only one of the many requirements food industries are forced to comply with. These challenges are: microbiological failures affecting food safety; chemical and physical contaminants into food products; other product-related (intrinsic) menaces against food safety, in terms of consumers' health; the demonstrable evidence of risk assessment in terms of clear and reliable documentation concerning safety, integrity, and legal designation of food and beverage products; and the evidence of continuous improvement by means of clear standard operative procedures, good manufacturing practices, and the execution of corrective/preventive actions against unavoidable food-related failures. The intrinsic connection between 'evidence' or 'demonstration' on the one side and the existence of documentations able to trace the production of foods and beverages on the other side should be established. This topic can be discussed by different viewpoints: the regulatory angle; technological perspectives; mathematical theories (networks, hubs, and nodes); and the opinion of food consumers. In addition, traceable food products may be also an interesting legacy for many geographical and ethnic cultures.

Keywords Hub · Food Business Operator · Network · Node · Off-line · Food Packaging Operator · Traceability

Abbreviations

AD/N	Average degree for node
GSFA	Codex General Standard of Food Additives
Comp	Complexity
EU	European Union
FAO	Food Agriculture Organization of the United Nations
FBO	Food Business Operator
F&B	Food and beverage
FMRIC	Food Marketing Research and Information Center

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FPO	Food Packaging Operator
IFT	Institute of Food Technologists
In	Interconnection
MD/N	Maximum degree per node
N	Node
OL	Off-Line

1.1 A General Introduction to Food Traceability

The modern industry of foods and beverages is forced to face many problems and concerns when speaking of public hygiene, food safety, regulatory requirements, traceability and authenticity questions, etc. (Beulens et al. 2005; Delgado et al. 2016, 2017; Mania et al. 2016a, b-2018; Parisi 2002, 2016; Parisi et al. 2016; Perreten et al. 1997; Phillips 2003; Pisanello 2014; Zanoli and Naspetti 2002; Zhang 2015). These matters could be mentioned in a general way as follows, considering that the list is not exhaustive:

1. Microbiological risks in terms of food safety and commercial requirements (Sheenan 2007a, b; Silva and Malcata 2000; Steinka and Parisi 2006);
2. Chemical risks affecting food safety, including decomposition, hydrolysis, and shelf-life determination (Barbieri et al. 2014; Vairo Cavalli et al. 2008)
3. Detection of foreign substances in foods (metals, plastics materials, wooden materials, nano-chemicals, etc.);
4. Other food-related risks affecting consumers' health;
5. Demonstrable evidence of risk assessment (safety, integrity, presence and declaration of food additives, nutritional claims, and legal designation of food and beverage products) (GSFA 2017; Haddad et al. 2020a, b; Silvis et al. 2017);
6. Reliable evidence of continuous improvement (in terms of standard operative procedures, good manufacturing practices, etc.), also with concern to food packaging requirements (Italian Institute of Packaging 2011).

Actually, the problem of demonstrable dangers (microbiological contaminations; the detection of prohibited food additives or foreign substances) can be understood by the main part of consumers, while other risks such as traceability may be difficultly managed and explained to the general population (Golan et al. 2004a, b; Mania et al. 2016a, b, 2018), depending on the 'active player' or 'subject' (Lauge et al. 2008; Mitroff et al. 1987; Olsen and Borit 2018; Parisi 2016; Haddad and Parisi 2020a, b; Parisi 2019).

By a general viewpoint, the 'traceability' of foods and beverages might be considered as the intrinsic connection between 'evidence' on the one side and the existence of documentations able to trace the production of foods and beverages on the other side (Parisi 2020). The importance of traceability is also notable when speaking of the reaction of food and beverage consumers (Buhr 2003; Cheek 2006; Chrysochou et al. 2009; Giraud and Halawany 2006; Golan et al. 2004a, b; Jasnen-Vullers et al. 2003; Sodano and Verneau 2004; Starbird and Amanor-Boadu 2006; Verbeke et al. 2007).

1.2 Some Definitions of Food Traceability. an International Perspective

It has been affirmed that traceability could be defined differently if the interested players/stakeholders are Food Business Operators (FBO), Official Inspection Bodies, Policy makers, or Food Consumers (Parisi 2020). Three definitions can be provided here with the aim of explaining better this concept.

According to the Food and Agriculture Organization of the United Nations (FAO) and its 'Food Traceability Guidance', food traceability is '*the ability to discern, identify and follow the movement of a food or substance intended to be or expected to be incorporated into a food, through all stages of production, processing and distribution*' (FAO 2017). Other official documentations are available on the National and the International level:

a. The 'Seafood Traceability Glossary: a guide to terms, technologies, and topics' document (Future of Fish, FishWise, and Global Food Traceability Center 2018);
b. The 'Handbook for Introduction of Food Traceability Systems (Guidelines for Food Traceability)' (FMRIC 2008);
c. The Food Safety Guidebook by Alberta Agriculture and Rural Development, Canada, 'Glossary of Food Safety Related Terms'—Appendix A (Alberta Agriculture and Rural Development 2014);
d. The 'Global Food Traceability Center, Glossary of Terms', Institute of Food Technologists (IFT), Chicago (IFT 2018);
e. The Regulation (EC) No 178/2002 of the European Parliament and of the Council (European Parliament and Council 2002).

The last document provides an interesting definition concerning traceability: '*The ability to trace and follow a food, feed, food producing animal or substance intended to be, or expected to be used for these products at all of the stages of production, processing and distribution*' (European Parliament and Council 2002).

Anyway, the practical basis of traceability cannot be fully understood without the comprehension of traceability pillars, as briefly expressed in Table 1.1, and some common points among different traceability definitions, as shown in Table 1.2. This matter is of critical importance in the modern world of foods, beverages, and food-contact materials worldwide (Epelbaum and Martinez 2014; Fiorino et al. 2019; Herzallah 2012; Hoorfar et al. 2011; Kim et al. 2018; Meuwissen et al. 2003; Schwägele 2005), because many controls and evaluations have to be based on reliable information which have to (a) be stored as soon as possible and (b) made available on request to interested 'stakeholders' with strict (and reasonable) timelines.

Table 1.1 Traceability pillars according to several documents and Organizations (Alberta Agriculture and Rural Development 2014; FAO 2017; FMRIC 2008; Future of Fish, FishWise, and Global Food Traceability Center 2018; IFT 2018; European Parliament and of the Council 2002; Parisi 2020)

Traceability pillars	Explanation
Batch Traceability	These words concern the basic work of a management system able to find and give evidence of information concerning moveable units under the same lot or batch number. The simple lot identification concerns similar features such as harvesting dates, peculiar names, and so on
Commercial Traceability	Similar to batch traceability, without the mention and public sharing of proprietary and/or confidential information
Electronic traceability	These words concern the amount of information obtained by means of a traceability management system based only on paperless information
External traceability	The basic work of a management system able to find and give evidence of information concerning moveable units under the same lot or batch number, as they move outside of the facility of the traceability manager
Internal traceability	The basic work of a management system able to find and give evidence of information concerning moveable units under the same lot or batch number, as they move into the facility of the traceability manager
Paper-based traceability	Differently from electronic traceability, these words concern the amount of information obtained by means of a traceability management system based only on paper-based documents information (although scanned images may be stored and used)
Chain traceability	The sum of all traceability information along the whole food chain, without exclusions (all FBO are considered)
One-step-back traceability	The sum of all important traceability information concerning received units (the information has to be received by the supplier)
One-step-forward traceability	The sum of all important traceability information concerning sold units (the buyer has to be clearly identified)

1.3 Food Traceability: Stakeholders, Hubs, and Nodes

Food traceability procedures have to concern all food and beverage (F&B) items and related players (stakeholders) at the same time. In this ambit, F&B stakeholders should be (Alberta Agriculture and Rural Development 2014; Brunazzi et al. 2014; FAO 2017; FMRIC 2008; Future of Fish, FishWise, and Global Food Traceability Center 2018; Haddad and Parisi 2020a, b; Mania et al. 2016b; Parisi 2012a, 2013, 2016, 2020):

1. Food business operators (FBO) which are involved in production. This category includes primary processors (growers, etc.), produce packers and re-packers,

Table 1.2 Common features of many traceability viewpoint (Alberta Agriculture and Rural Development 2014; FAO 2017; FMRIC 2008; Future of Fish, FishWise, and Global Food Traceability Center 2018; Hosch and Blaha 2017; IFT 2018; European Parliament and of the Council 2002; Mania et al. 2018; Parisi 2020)

Traceability Common Points	Explanation
Identification	Each material used for foods and beverages, or the food and beverage itself, is identified by means of data. One (or more) dataset represents virtually the unit
Ability	It should be requested to all possible players of the food chain because of the nature of the material identified
Movement	Each material used for foods and beverages, or the food and beverage itself, can be identified by means of data on condition that an input is considered at the start of a process, and an output is generated at the end
Downstream	The direction of the supply chain with all possible stages in the food production process involving processing, packaging, and distribution
Upstream	The opposite direction of downstream in the supply chain
'Tracing forward' or 'tracking'	The information concerning moveable units and the related process(es) can be considered in the downstream direction (from raw materials to final products) or in the upstream direction (from final products to raw materials)
'Tracking back' or 'tracing'	The information concerning moveable units and the related process(es) in the upstream direction (from final products to raw materials)
Lot or Batch	A food unit, or a homogeneous group of food units, have to be clearly identified by means of reliable identification keys such as production dates, best-of-use dates, sequential numbers, etc.
Large-scale (or external) traceability	The traceability system can operate with the synergic action of many operators
Small-scale traceability	The system should operate only within the boundaries of an operator. Also defined 'internal traceability' (Table 1.1)

livestock producers, food processors, suppliers of crop protection and/or seeds and plants, etc.

2. F&B packaging producers, also named Food Packaging Operators (FPO);
3. F&B traders, distributors, importers, and exporters. Third-party logistics service providers may be included here;
4. F&B mass retailers (generally working on a large-scale dimension, although little and average-sized retail stores are often found in this sector);
5. Other FBO: catering operators, chain restaurants, universities, hotels, government and hospital cafeterias, etc.
6. F&B consumers;
7. Official Safety Authorities;

8. The Academia, third-party certification bodies, food lawyers, technical consultants, journals, magazines, private research centres, social media, etc.

The network of interested players should comprehend only 'inner' stakeholders in the strict ambit of food production/movement/processing/distribution, as shown in Fig. 1.1. This basic structure comprehends five possible connections or 'nodes' representing five players in the food chain. Interestingly, the ideal process should follow a simple direction, from the left to the right only, and each theoretical F&B unit (or item) would be obliged to enter a specific node, from primary production to final retail, without 'skipping' options (Parisi 2020).

The 'node' term comes from 'Seafood Traceability Glossary: a guide to terms, technologies, and topics' document (Future of Fish, FishWise, and Global Food Traceability Center 2018). In brief, each node can be considered as '*a distinct entity in a supply chain (…) that may be responsible for capturing, inputting, storing, or sharing data*'. As a result, a food traceability network—similarly to the real commercial network of FBO and other players—would be an interconnected matrix of nodes (Parisi 2020), from harvesting activities or similar options, towards the market and/or processors, distributors, and retailers.

This representation is simple enough. Unfortunately, the real food network could have more than a single FBO or stakeholder per step. In other time, F&B units have to be defined as a single entity, while interested players may be more than one operator only per step. Usually, the main part of food products appears to be sold by retailers, in the European Union (EU) at least (Fig. 1.2, pathways B and C). On the other hand, many primary producers and processors could sell their products to

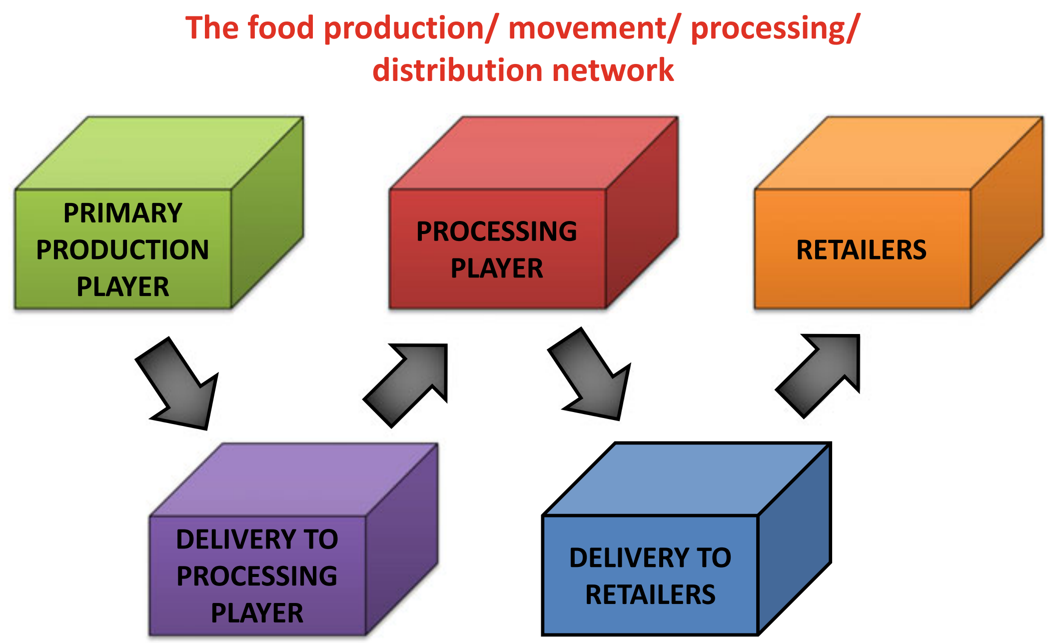

Fig. 1.1 This basic structure comprehends five possible connections or 'nodes' representing five players in the food chain. F&B items should not skip mentioned steps (Parisi 2020)

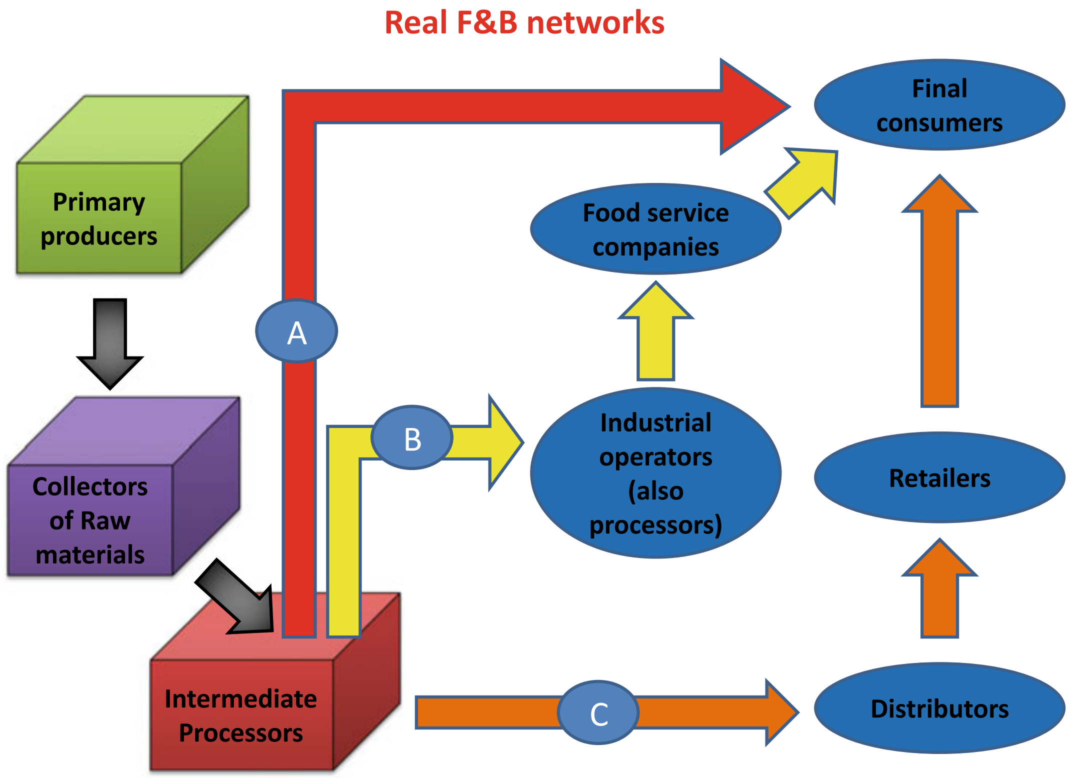

Fig. 1.2 Real F&B networks could have more than a single FBO or stakeholder per step. Many primary producers and processors could address their products to food service companies (catering, etc.) and final consumers at the same way (pathway A, red colour), or to industrial operators (food companies where cheeses are only one of the many ingredients; pathway B, yellow colour), or to distributors (pathways C, orange colour)

non-retailer companies for further processing (pathway A). This matrix is shown in Fig. 1.2: the complexity of similar networks depends also on two features (Future of Fish, FishWise, and Global Food Traceability Center 2018; Parisi 2020):

a. The 'fragmentation' (certain steps are located in different places or by different companies at the same times);
b. The 'horizontal concentration' of nodes in the food chain (only a small number of companies operate at a single step, accumulating food units from a multiplicity of small suppliers). In this situation, the flow of commodities and the price of F&B products is influenced and substantially managed into a single node.

The study of food traceability networks could be simplified by means of the analysis of the degree of different nodes. In ould be considered with attention (Biggs et al. 1986; Chartrand 1985; Nykamp 2018; Parisi 2020):

1. The degree of a node may be defined as the number of interconnections between a specified node and surrounding nodes
2. The degree distribution has to be defined as the probability distribution of all possible degrees in relation to the entire network.

Each shown node may have an exact number of ‘ingoing’ connections (entering the node) and another different number of connections exiting the node (outgoing the node). In addition, there are two possible directions:

1. From left to right, from raw materials to final products (UPSTREAM), and
2. From right to left, from final products (or intermediates) to the immediately previous step (in the opposite direction, or DOWNSTREAM).

The second option should be always considered because of the possibility of recycling operations concerning reworking materials. Also, the possibility of more than one processor only per step has to be taken into account. In general, the complete network should have only a preferential direction: from raw materials to final products, step by step. In this situation, the distribution of node degrees could be represented by means of a simple binomial distribution (Parisi 2020) where the X-axis shows node degrees and the Y-axis concerns the ration between each node and the total number of nodes. Figures 1.3 and 1.4 show three options:

a. #1 Network: a four-node network where each interconnection is directed in the preferential direction only (raw materials → final products). This network is on the upper side of Fig. 1.3.

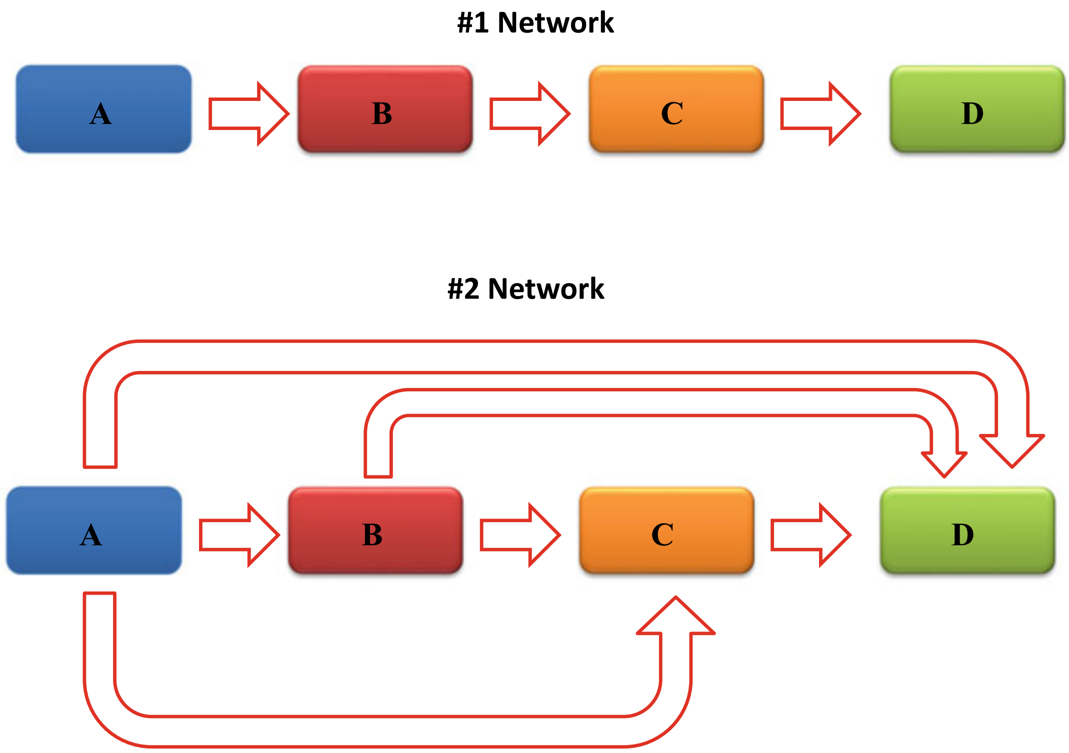

Fig. 1.3 Two simple supply chain networks with four nodes A, B, C, and D. nodes. Figures 1.3 and 1.4 show three options: (d) #1 Network: a four-node network where each interconnection is directed in the preferential direction only (raw materials → final products). This network is on the upper side of Fig. 1.3 (e) #2 Network: a four-nodes network showing three specific nodes with three, two, and one interconnections in the preferential direction (raw materials → final products), respectively. This model is on the lower side of Fig. 1.3)

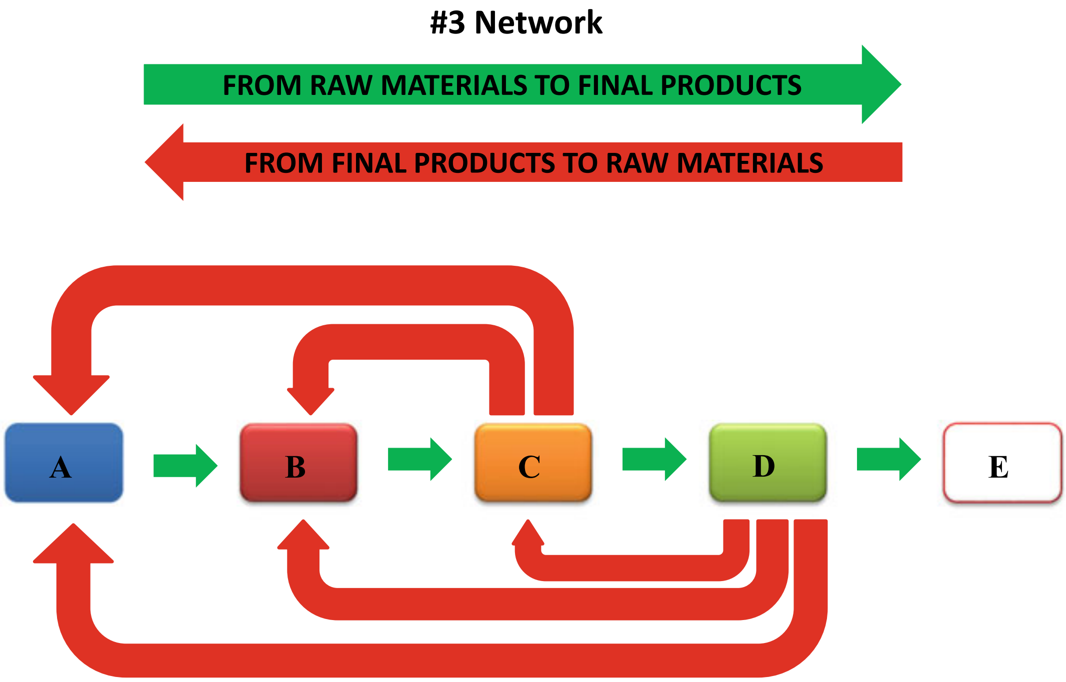

Fig. 1.4 A five-nodes network showing four nodes with four interconnections, but nodes C and D have also two outgoing connections directed towards A & B, and B & C, respectively

b. #2 Network: a four-nodes network showing three specific nodes with three, two, and one interconnections in the preferential direction (raw materials → final products), respectively. This model is on the lower side of Fig. 1.3.
c. #3 Network: a five-nodes network (Fig. 1.4) showing four nodes with four interconnections, but nodes C and D have also two outgoing connections directed towards A & B, and B & C, respectively.

Each network can be expressed by means of a distribution showing node degrees on the X-axis, and the fraction of nodes on the Y-axis (Parisi 2020). Figures 1.5, 1.6, and 1.7 show the situation concerning #1, #2, and #3 networks, respectively.

The existence of more than two connections per node (one ingoing and one outgoing relationship) means that certain nodes can represent a 'hub' (high number of interconnections). Consequently, the distribution of ingoing and outgoing relations in two directions has to be graphed two times with relation to in-degree and out-degree on the X-axis.

In general, the distribution of outgoing relations in the non-preferential (DOWNSTREAM: final products → raw materials) direction is low enough when speaking of food chains. For this reason, the complexity of these networks (including their virtual representation, traceability systems) is directly dependent on the distribution of ingoing relations in the preferential direction (Nykamp 2018; Parisi 2020). The higher the ratio between the total number of degrees and the number of nodes, the more complex the whole network, and vice versa. Moreover, three considerations should be evaluated in this specific ambit (Parisi 2020):

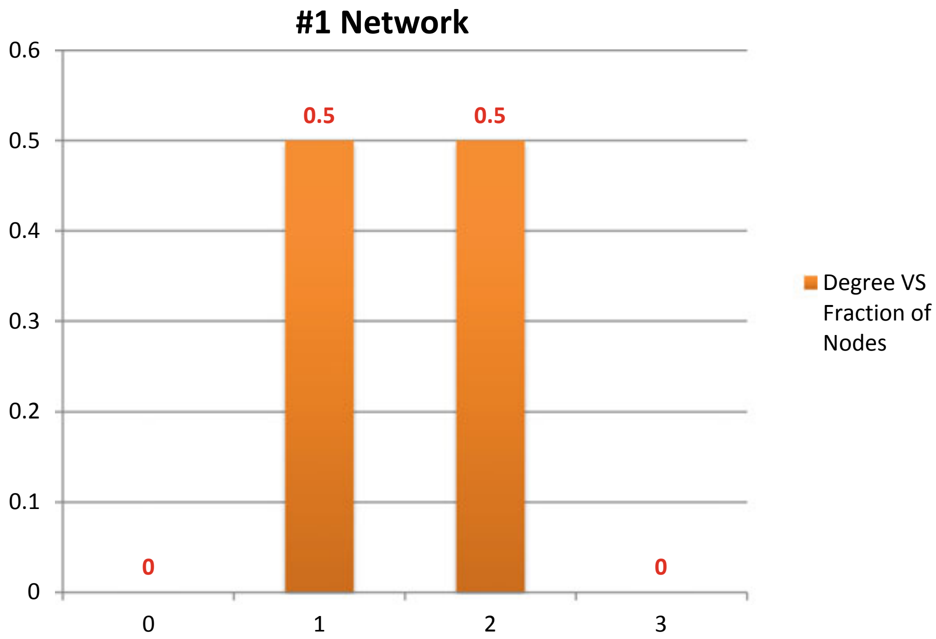

Fig. 1.5 Distribution of degrees for a four-node network where each interconnection is directed in one direction only (from raw materials to final products, UPSTREAM). The #1 network is on the upper side of Fig. 1.3

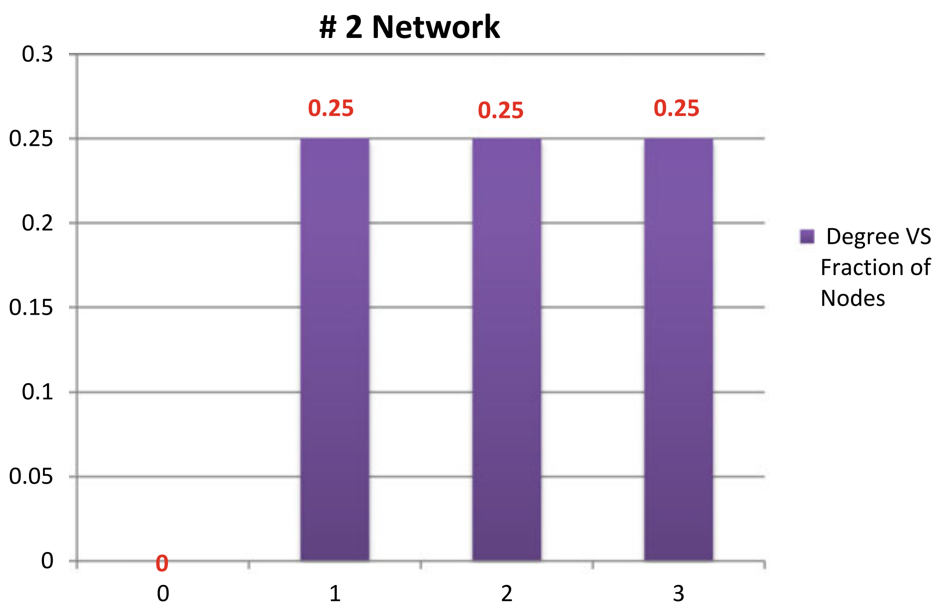

Fig. 1.6 Distribution of degrees for a four-node network shows three specific nodes with three, two, and one interconnections in the preferential direction (raw materials → final products, UPSTREAM), respectively. The #2 network is on the lower side of Fig. 1.3

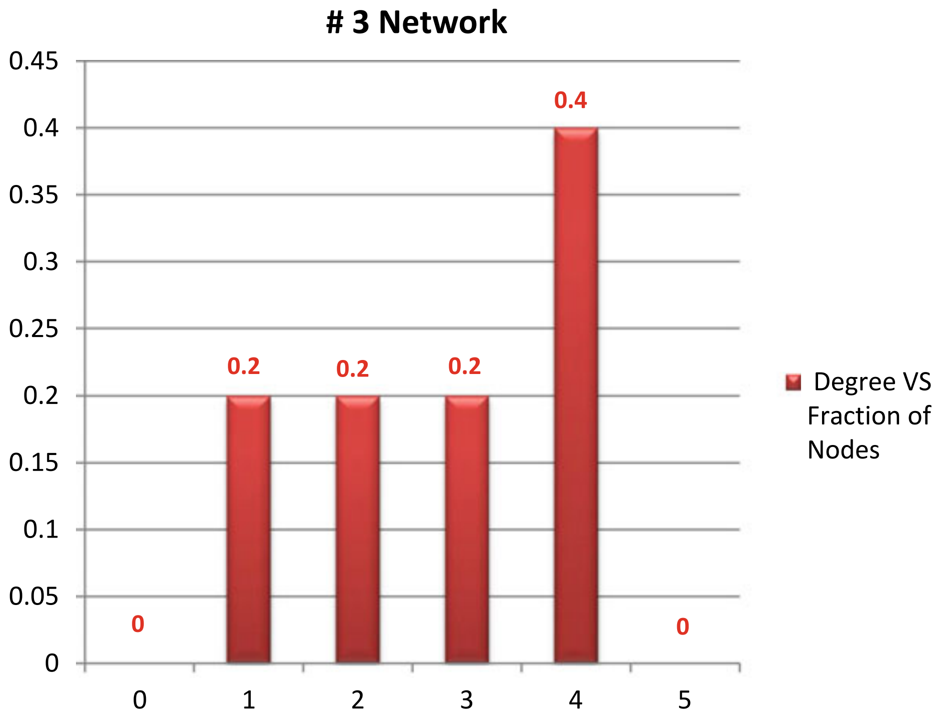

Fig. 1.7 Distribution of degrees for a five-node network (Fig. 1.4) shows three nodes with four interconnections, but node C has two outgoing connections directed towards A and B (opposite direction if compared with raw materials to the final product)

a. A distribution with low ratios tends to be placed on the left of the graph. The network tends to be simple with a high number of nodes showing low degrees. Consequently, this model would be easily managed provided that each node can perform well alone, but this situation is not simple (and a general manager with monitoring activity for the whole network would be needed…)
b. A Gaussian or quasi-Gaussian distribution should be placed preferentially at the centre of the graph (average or high ratios). The system tends to be more and more complex with an average number of nodes (hubs) having high degrees. The network might be managed by one or more of these hubs; on the other hand, the global performance of similar systems depends entirely on the performance of these hubs only (different companies). #1 and #2 Networks appear in this situation (Figs. 1.5 and 1.6)
c. A non-Gaussian distribution showing only high ratios (a very small number of hubs). In this ambit, the management of the whole information (or logistic) system should be managed by one of these hubs only. The risk of a complete downfall is linked to the ability of this hub (or company). #3 network might be similar, while Fig. 1.7 shows a complex system with these features (number of interconnections: 18). The related distribution with high ratios tends to be placed on the right side of the graph.

In the ambit of traceability and food chain networks, the ratio between the total number of degrees and the number of nodes may show related complexity if each node has 0, 1, or 2 maximum connections. Also, the comparison between this ratio and the same value obtained with the maximum degree of nodes would give a percentage idea of the complexity. By a mathematical point of view, the following procedure may be proposed (Parisi 2020):

a. The ratio between interconnections (In) and nodes (N), named 'average degree' for node (AD/N) is:

$$\mathrm{AD}/N = \mathrm{In}/N \times 100 \tag{1.1}$$

b. The 'complexity' (Comp) of the whole network is the % ratio between AD/N and the maximum degree per node (MD/N), as follows:

$$\mathrm{Comp} = \mathrm{AD}/N/\mathrm{MD}/N \times 100 \tag{1.2}$$

Consequently, should In = 6 and $N = 4$ only for a network while MD/N is 2.0, the following results could be obtained by means of Eqs. 1.1 and 1.2:

$$\mathrm{AD}/N = 6/4 = 1.5,$$

and

$$\mathrm{Comp} = 1.5/2.0 \times 100 = 75\%$$

On the other hand, should In = 14 and $N = 5$ with MD/$N = 4$ (this high value means that one of nodes at least is a hub), the following results could be obtained by means of Eqs. 1.1 and 1.2:

$$\mathrm{AD}/N = 14/4 = 2.8,$$

and

$$\mathrm{Comp} = 2.8/4.0 \times 100 = 70\%$$

Two reflections should be made on these bases. The first of these examples concerns a simple network with no hubs (AD/$N = 2$) and a notable complexity (75%). This situation is explainable because AD/N and MD/N are close enough. On the other hand, the second example shows MD/$N > 2$ (one or more hubs), as also confirmed by calculated AD/N (2.8 > 2). However, complexity seems lower than in the first example (70 vs. 75%). The difference between the two situations is the recommended use of a centralised managed in the second network because one hub at least is present, and it could represent the possible 'weak ring' of the chain. Should one (or more) of these nodes fail to transfer information, the whole traceability system would easily collapse (Parisi 2020). On the other side, the first system would not necessarily need a centralised manager. On these bases, the performance of these networks would be similar. Anyways, the important factor is the MD/N value: should this number be 5.0 in the second situation, Comp value would be 56% (lower complexity), but the hub with node degree = 5.0 would be the real and critical point of the system… Should all food chain players agree, this step—and the interested players—would represent the real monitoring manager avoiding the possible downfall (Parisi 2020).

1.4 The Food Unit as the Basic Pillar of Food Traceability

Each food item, also named ‘food unit’, has to be clearly identified. In detail, several information concerning the identification of food units should be provided (FAO 2017; Parisi 2020):

a. Name of the FBO (contact addresses, phone, e-mail addresses, other company data, etc., concerning both the main headquarter and all possible additional sites, if needed)
b. The name of the person working on traceability services for the FBO (it is strongly recommended that this manager has to be always available, unless one or more substitutes are present and specifically nominated)
c. The management plan for traceability of the FBO. This plan may be part of general quality management systems in the company.
d. The shelf life or expiration date of the food unit
e. Recommended storage procedures for the food unit, including logistic aspects
f. The Nation of origin, with additional data concerning possible outsourcers, external manufacturers, and/or exporter companies.

All information have to be adequately recorded and stored for each product, food, or substance intended to be found into foods, or used in food production and/or packaging (Piergiovanni and Limbo 2016). Consequently, there are only traceable ‘food units’. According to the FAO (2017), three food categories for sale may be considered:

1. A packaged food or beverage unit (also constituted of more than one unit in a single macro-product unit)
2. A logistic unit (sum of many units). In this ambit, the final consumer is not accustomed to see logistic units such as prepared mass of ordered commodities placed on wooden or plastic pallets (Steinka and Parisi 2006)
3. A shipment of F&B units.

The problem of traceability is linked to two different aspects (Parisi 2020):

a. F&B units have to be traceable and traced always (in each moment)
b. Traceability records, managed by centralised monitoring agents or by each player of the traceability network (Sect. 1.3), should be made available on request immediately, and stored for a specified time.

With reference to the last point, it is difficult to find a general quality manager which is able to monitor also traceability. In other words, a different function—the traceability manager—should be considered.

1.5 The Flow of Input and Output Information with Mathematical Implications

According to the ‘Hygiene, Integrity, Traceability, and Sharing’ strategy (Haddad and Parisi 2020a, b), traceability procedures are critical and represent one of main pillars in the quality and safety management of food and beverage industries. This requisite is mandatory, required worldwide (Allata et al. 2017; Chen 2017; King et al. 2017; Lewis et al. 2016), and it is mentioned also in certification standards such as Global Standard for Food Safety (by the British Retail Consortium, UK), and the International Featured Standard (IFS) Food (Bitzios et al. 2017; Jin et al. 2017; Mania et al. 2018; Nicolae et al. 2017; Parisi 2020; Stilo et al. 2009; Telesetsky 2017). The list of interested F&B products and services is virtually infinite (Kok 2017; Lacorn et al. 2018; Moyer et al. 2017; Pisanello and Caruso 2018; Silvis et al. 2017).

With concern to mandatory requirements, the European Regulation (EC) No 178/2002 is a good explanation when speaking of the European ambit, even if this Regulation is completed with other specific regulator norms (European Commission 2004, 2006, 2008, 2011, 2013; European Parliament and Council 2002, 2003a, b, 2009, 2014).

However, the problem of traceability is also a matter of mathematical balances… because all ingredients of interest have to be inserted into a ‘flow’ towards the final product. This concept is true from the production and technological viewpoint. At the same time, the flow of information is a virtual representation of the technological process, and the whole traceability system (as a mass of organised paper documents, or an electronic storing and recording software) has to take this point into account. Figure 1.8 shows a general figure while five different ingredients (and related information) enter the flow of input data towards the final food or beverage (ideally representing the output product with associated output data: name, brand, lot, etc.).

A premise should be made in the world of F&B products concerning the nature of entering information. What about… water? Water—sometimes named ‘the blue gold’—is absolutely needed in food industries for many purposes… including the role of ingredient (and solvent also…). Basically, the equation representing the balance between ingredients and the final product:

$$\left[\text{Sum of all ingredients}\right] = \left[\text{Finished product}\right] \tag{1.3}$$

should contain a mistake: the absence of water, with several exceptions… Consequently, this balance may be replaced with the following Eq. 1.4, when needed (Mania

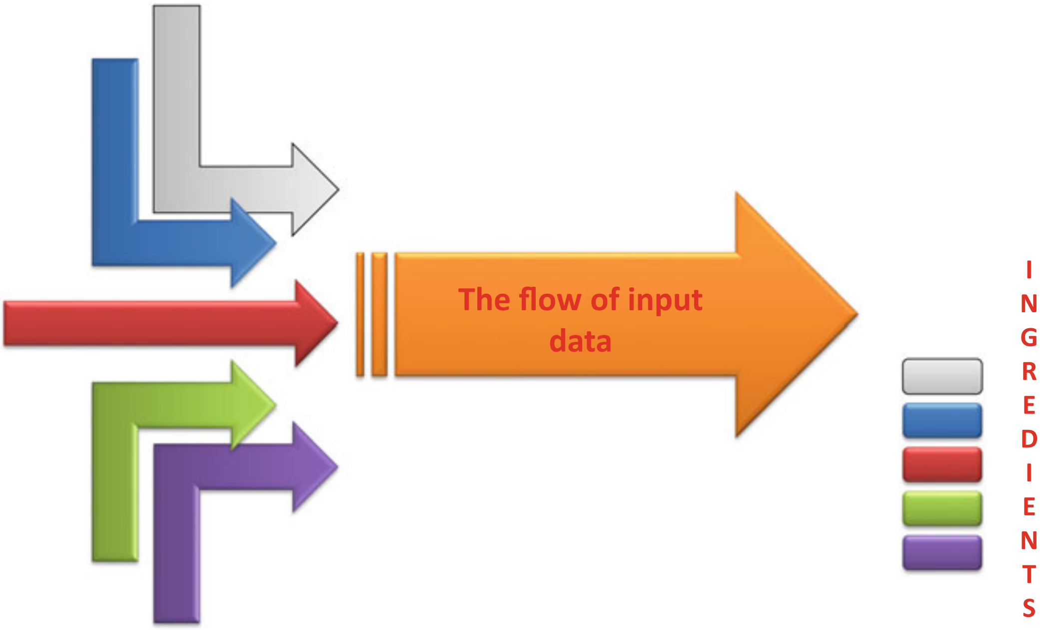

Fig. 1.8 Five different ingredients (and related information) enter the flow of input data towards the final food or beverage (ideally representing the output product with associated output data: name, brand, lot, etc.)

et al. 2018):

$$\begin{aligned}&\left[\text{Sum of all ingredients excluding added water}\right] + [\text{Added water}]\\&= \left[\text{Finished product}\right]\end{aligned} \tag{1.4}$$

Another important consideration should concern the number of 'final products', because normal processes generate the final product itself and 'n' possible by-products. As a result, Eq. 1.4 should be amended again. These by-products may be defined 'Reworking' or 'Off-Line' (OL) products, corresponding to the difference between the total amount of produced intermediates in a specific process, and the quantity of final products that can be sold. Also, added water could be partially lost (and other ingredients could loss water…). Consequently (Mania et al. 2018; Parisi 2020):

$$[\text{OL}] = \left[\text{Sum of products}\right] - \left[\text{Marketable products}\right] \tag{1.5}$$

Finally, Eq. 1.4 would be amended correctly as follows:

$$\begin{aligned}&\left[\text{Sum of all ingredients excluding added water}\right] + [\text{Added water}]\\&= \left[\text{Finished product}\right] + [\text{OL}] + [\text{Lost water}]\end{aligned} \tag{1.6}$$

where:

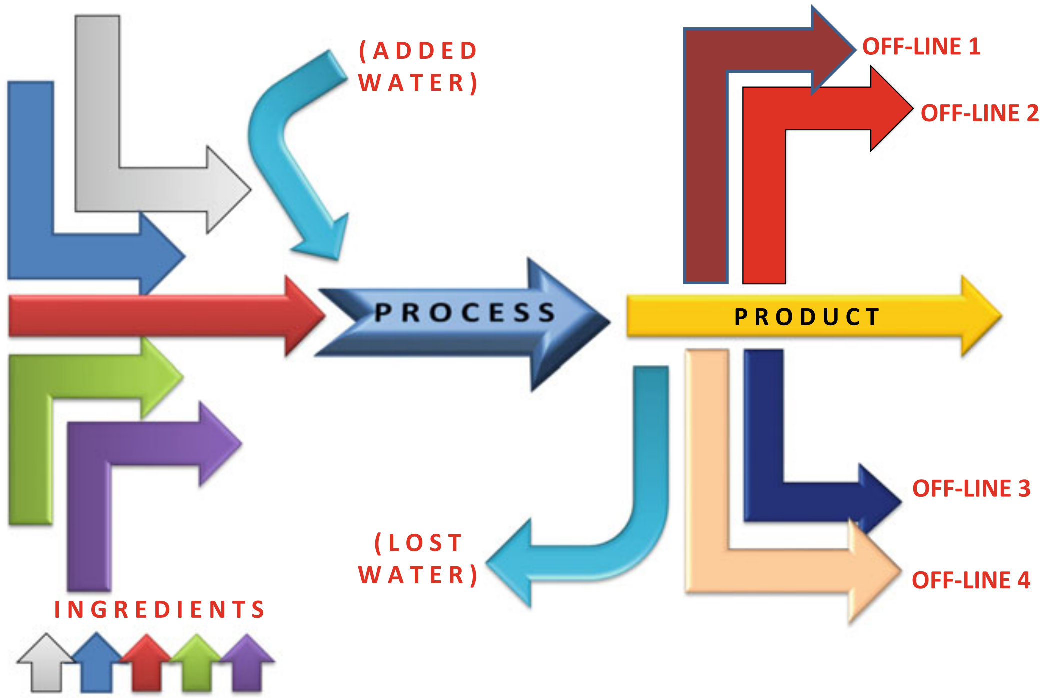

Fig. 1.9 Traceability requires all possible input and output data in a process, including also added water and lost water (Eq. 1.6). This approach should give evidence of all raw materials and other ingredients (on the left), while output information is on the right (marketable products, OL, and possible lost water). This example shows five ingredients and added water on the left side of the image, and the final product with four OL and lost water on the right

$$\left[\text{Finished product}\right] = [\text{marketable products}] \tag{1.7}$$

The situation expressed by Eq. 1.6 is generally observed in the F&B industry, although the application depends on the peculiar product and the concerned industries… Fig. 1.9 shows the flow of input (on the left = ingredients) and output (on the right = final products + OL + possible lost water) information concerning the flow of traceability data.

1.6 Food Traceability… and Packaging Materials?

Obligations and requirements linked to food traceability should consider also the role of food-contact materials, probably seen by the main part of interested stakeholders as ‘accessory’ ingredients (Mania et al. 2016a, b, 2018; Parisi 2009). However, the role of these non-edible materials has been recently considered with extreme attention, in accordance with the (EC) Regulation No 1935/2004 in this ambit (European Parliament and Council 2004). This regulatory document of the European Union states clearly (Article 17, point 1) that ‘*The traceability of materials and articles shall be ensured at all stages in order to facilitate control, the recall of defective* *products, consumer information and the attribution of responsibility*'. As a result, FBO have to assure the correct identification of food packaging materials (FCM) when speaking of the following data (Parisi 2020):

1. Origin;
2. Name and identification of the initial supplier;
3. Date of production (also named batch);
4. Name of the consignee;
5. And other data of interest, considering the non-edible nature of these materials.

Anyway, the meaning of 'traceability' in this ambit is not different from food-related definitions. In accordance with the (EC) Regulation No 1935/2004, Article 2, point 1, comma a, '*the ability to trace and follow a material or article through all stages of manufacture, processing and distribution*'.

As an obvious consequence, the extended traceability system should not only consider edible ingredients and products (Eq. 1.6, Fig. 1.9), but also food-contact materials at the same time! Also, the mandatory requisite of traceability (also considered by dedicated food certification systems) has to be satisfied by FBO and FPO at the same time and worldwide (Allata et al. 2017; Chen 2017; Kawecka 2014; King et al. 2017; Lewis et al. 2016; Mania et al. 2018; Parisi 2020; Stilo et al. 2009). Relations between food traceability and safety matters concern all components of F&B products, including FCM, and the possible list of reasons (including potential safety risks and commercial failures) could be really infinite (Kok 2017; Lacorn et al. 2018; Moyer et al. 2017; Parisi 2012a, b, 2013; Pisanello and Caruso 2018; Silvis et al. 2017).

For these reasons, it should be highlighted that traceability represents a great effort, aiming at giving the evidence of an entire flow of information among all interested players and stakeholders of the food chain with a continuous data exchanging (Mania et al. 2018). In this ambit, FBO and PBO should be able to demonstrate their compliance to traceability requirements always… This objective can be really difficult because of the virtually infinite list of F&B products on the national and international markets. This book would give a good analysis of traceability problems taking into account many information related to three categories of foods currently found in the Middle East, and particularly in Jordan. In the ambit of traceability and related data, Chapter 2 is dedicated to traditional *hummus* and related variations, while Chapters 3 and 4 concern Jordanian concentrated strained yogurt (*labaneh*) and dried fermented dairy foods (*jameed*).

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