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Review

Literature review of deteriorating inventory models by key topics from 2012 to 2015

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ABSTRACT

The aim of this work is not only to give an up-to-date review of perishable inventory models, but also of the joint key topics of publications from January 2012 until December 2015 in the research area of deteriorating inventory models. The advantage of this review is the ability to quickly find papers according to given key topics. Methodically, this paper is based on the literature review of Bakker et al. (2012). However, we slightly modify the classification of inventory models of perishable goods in our work, and extend the existing key topics.

Contents

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1. Introduction

The development of inventory models for perishable goods begins in the 1960s. Publications in this research area have already been documented until the year 2011. One of the first important models for perishable goods with a lifetime (shelf-life) of two periods was published by van Zyl in 1964 (Nahmias, 2011). Since then, there have been 17 literature reviews on this topic: Silver (1981), Nahmias (1982), Raafat (1991), Goyal and Giri (2001), Bakker et al. (2012), Lim et al. (2013), Wang (2013), Li et al. (2010), Lowalekar and Ravichandran (2013), Stanger et al. (2012b), Beliën and Forcé (2012), Prastacos (1984), Pierskalla (2004), Karaesmen et al. (2011), Nahmias (2011), Pal et al. (2014), and Amorim et al. (2011). These literature reviews are depicted graphically in Fig. 1. In Fig. 1, the following information is shown for each review: the period of publication, the number of references, authors and publication year of the review, research area (optional). There are hundreds of papers on this subject which were published over several decades.

Nahmias (1982) provides the first comprehensive review on the problem of determining suitable ordering policies for both fixed lifetime perishable inventory, and inventory subject to continuous exponential decay. Raafat (1991) provides the survey of literature on continuously deteriorating inventory models until 1990. He carries out classification according to Silver (1981), who points out gaps between theory and practice in inventory management in his work. Goyal and Giri (2001) expand the review from Nahmias (1982) and Raafat (1991) by a further ca. 130 literature sources from 1990 to the year 2000. They classify the papers differently than Nahmias and Raafat. Bakker et al. (2012) continue with the literature review of Goyal and Giri (2001) from 2001 until 2011 and consolidate 227 relevant papers. Li et al. (2010) build on the works of Raafat (1991) and Goyal as well as Goyal and Giri (2001), however, they categorize and structure the existing work differently than the referenced authors. Wang (2013) create a review of inventory management modes based on supply chain management (SCM) and structure the papers based on one-echelon, two-echelon and multi-echelon inventory management modes. A review of RFID in warehousing use is given by Lim et al. (2013). Summary of the literature on blood banks is found in review papers Prastacos (1984), Pierskalla (2004), Beliën and Forcé(2012), Stanger et al. (2012b), and Lowalekar and Ravichandran (2013).

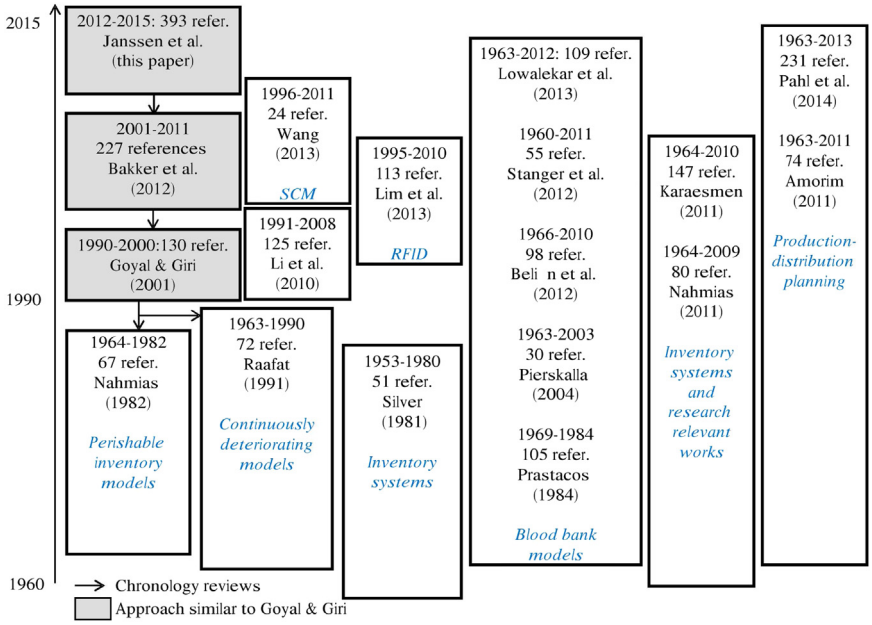

Fig. 1. A survey of literature reviews for deteriorating inventory models.

Nahmias (2011) and Karaesmen et al. (2011) provide literature reviews of relevant and research-stimulating works on the issues of 'Perishable Inventory Systems' or 'Managing perishable and aging inventories'. The main focus of the literature review of Pal et al. (2014) and Amorim et al. (2011) is production planning. However, Pahl et al. include additional papers on the topic of supply chain planning and Amorim includes papers on distribution planning.

Between January 2012 and December 2015, a total of 393 academic articles dealing with deteriorating inventory models were published. This is circa 99 papers per year, on the average. The last literature review of Bakker et al. (2012) included 227 papers for 11 years. This corresponds to an average of 21 papers per year. Hence, the average number of papers over the last years has increased strongly (by 4.7-times).

Not only the number of inventory models for perishable goods has risen notably, but also the multitude of possible key topics contained in one paper has increased significantly. For example, one paper may contain optimal pricing and ordering policies or the optimization of order quantity for deterioration items with regard to credit or inflation or investment and so on. The joint key topics in a paper and their wide variety in current papers leads to the necessity, to present these in a review as briefly and clearly as possible. The objective of our work is to bring together all relevant papers in this research area and to create such a key topics review.

Methodically, we approach the search, analysis and classification of inventory models as in the work of Bakker et al. (2012). Thus, our work may be considered a successor to the work of Bakker et al. However, unlike Bakker et al. we have included newsvendor (48 papers) and transport models (36 papers) for perishable goods in our review. Furthermore, we implement several necessary extensions to the classification of models and key topics, which will be described subsequently in more detail.

In Section 2, the basic categories for classification of current inventory models are introduced. Section 3 describes our research method for the allocation of academic publications for this research area. Furthermore, we present statistics to journals analog to Bakker et al., which have published the current papers. In Section 4 the classification of deteriorating inventory models is introduced. In Section 5 the key topics review is presented. Section 7 presents future research key topics. Finally, the analysis is found in Section 6 and thereafter a conclusion (Section 8) to this work.

2. Types of inventory models based on deterioration and demand

Here we give a brief overview of the classification of inventory models. For a detailed description of deterioration of items and deterministic and stochastic demand we refer to the literature review of Goyal and Giri (2001).

There are constant, stock-level-dependent, stock-age-dependent, price-dependent demands and others (Table 4). Also, multivariant demand is possible. In Goyal and Giri (2001) and Bakker et al. (2012) these are given as subcategories of deterministic demand. In more recent papers, stochastic demand as well may be dependent on price, stock-age and other parameters, for example in Abad (2014), Amorim et al. (2013), Baron et al. (2015), Cai et al. (2013), Maihami and Karimi (2014), and Yu et al. (2013b). Therefore, we have modified this breakdown in subcategories, as in the literature review by Bakker et al. (2012). These subcategories are now changed to categories for deterministic and stochastic demand.

2.1. Deterioration

Perishable goods are modeled in an inventory model with a known fixed lifetime or with a random lifetime. However, a random lifetime with regard of maximum fixed lifetime is also possible, for example Amorim et al. (2013), Avinadav et al. (2014), Chen and Teng (2014), Ketzenberg et al. (2014) and others. Inventory models which only consider lifetime with the known a priori deterministic (fixed) lifetime belong to models for *fixed lifetime*. All other models with probabilistic distributed lifetime (e.g. Weibull), constant, known, unknown deterioration rate etc. are defined as models for *random lifetime* products. We have classified inventory models with simultaneous deteriorating rate and fixed lifetime under models with random lifetime, because the model definition corresponds most fittingly.

2.2. Demand

Within the classification of models, demand (deterministic or stochastic) plays an important role (Goyal and Giri, 2001). Initially, as in the review by Bakker et al. (2012), demand is divided into two categories: deterministic and stochastic. The *deterministic* demand is already known at the time of planning and the *stochastic* demand is unknown at the time of planning. Often the probability distribution of the stochastic demand is known or stochastic demand is modeled as arbitrary probability distribution. Models with fuzzy demand are counted here as stochastic models.

3. Method

3.1. Search and first reading phase

In this step, the search and the first preselection of papers took place and missing papers were attained. The search for academic publications on deteriorating inventory systems for the period 2012–2015 was carried out in a similar way as described in Bakker et al. (2012, p. 276). Exactly in this manner, we used in our search the terms 'deteriorate* AND inventory', 'perish* AND inventory', 'shelf life AND inventory', 'decay AND inventory', whereby 'AND' is the logical link between the two search words. In this search further key words such as 'spoil* AND inventory', 'outdate* AND inventory' and 'waste AND inventory' were used. First, the journals from the paper Bakker et al. (2012, p. 277) were researched. In addition to that, websites were researched (sciencedirect.com, tandfonline.com, onlinelibrary. wiley.com, hindawi.com, palgrave. com, inderscience online.com, informs.org, hindawi.com, ebsco-host.com, academic.research. microsoft.com, springerlink.com, wiso-net.de, gso.gbv.de, scholar.google.com). Furthermore, proposed papers from publishers were examined.

We have chosen the free tool Mendeley (http://www.mendeley.com) as the reference manager for the collection of papers. The management and sorting of references is simple and flexible with this tool.

3.2. Relevant papers and classification phase

In this step, all papers were reviewed a second time. The publications which were not chosen in the selection process were removed. The remaining publications were then classified for Table 3 in Section 4 according to demand and deteriorating types. Publications as 'Notes' to other articles and literature reviews were not classified, therefore these are not listed in Table 3.

3.3. Sorting of papers according to key topics

Finally, all current papers were sorted by key topics in Table 5 in Section 5, whereby a paper can have several key topics. Furthermore, the key topics themselves were modified over time, given impetus from the issues of the papers themselves.

3.4. Counting and logging of papers

In this phase, the types of papers were counted and documented accordingly. To the best of our knowledge, all references were classified correctly. In order to avoid an error rate caused by the manual summarization of results, we entered all associations between key topics and papers in a relational database and automated the counting and logging of results with the help of SQL queries. Despite the thorough review of papers, it is possible that something was overlooked. The authors of papers who would like an update may add their corrected entry directly under URL http://bit.ly/1nndRA6. The finished key topics literature review is described in Section 5.

3.5. Journals statistics

A consistency among all journals publishing in the research area 'Deteriorating inventory models' does not exist. Several journals do not publish within this area anymore. Other journals, on the other hand, have now incorporated the research area.

In Table 1 we show the number of papers in the journals which we found in Bakker et al. (2012, p. 277) in Table 2. With the help of these statistics on journals, one can follow how the number of published papers has changed. Based on our assessment, most of the papers (58 papers) are still published in the 'International Journal of Production Economics'. The number of publications in the following journals has increased considerably, if one considers that the previous literature review of Bakker et al. covers 11 years and our literature review includes 4 years: 'Annals of Operations Research' (1 vs. 14 papers), 'Applied Mathematical Modelling' (7 vs. 21 papers), 'Applied Mathematics and Computation' (2 vs. 11 papers), 'Mathematical Problems in Engineering' (1 vs. 16 papers), 'Operations Research' (1 vs. 39 papers), and 'Omega' (1 vs. 11 papers).

In several journals from Table 2 (Bakker et al., 2012, p. 277), no new papers on the topic 'Deteriorating inventory models' could be found, and some of the journals were no longer published ('Applied Modelling & Optimization', 'International Journal of Information and Management Sciences' for example). At the same time, we found several other journals which publish research in this area. The journals with up to three papers are consolidated in Table 2. The 'International Journal of Production Research' should be especially noted, because many papers (15) were published here.

In Tables 1 and 2 367 papers are consolidated. The remaining 26 papers are published in journals or international conferences which are not listed in the Tables 1 and 2.

Table 1
Continuation of the overview of the number of articles on deteriorating inventory between 2012 and 2015 per journals after Bakker et al. (2012, p. 277).

Journal	Papers
Annals of Operations Research	14
Applied Mathematical Modelling	21
Applied Mathematics and Computation	11
Computers & Industrial Engineering	17
Computers & Operations Research	5
European Journal of Industrial Engineering	1
European Journal of Operational Research	20
Expert Systems with Applications	2
Fuzzy Optimization and Decision Making	1
IIE Transactions	4
International Journal of Physical Distribution & Logistics Management	1
International Journal of Production Economics	58
International Journal of Systems Science	28
International Transactions in Operations Research	5
Journal of Computational and Applied Mathematics	1
Journal of the Operational Research Society	5
Mathematical and Computer Modelling	4
Mathematical Problems in Engineering	16
Mathematics of Operations Research	1
Naval Research Logistics	1
Omega	11
Operations Research	39
OR Spectrum	1
Production and Operations Management	4
Production Planning & Control	1
Total papers:	272

Table 2
Further journals with number of articles ≥ 3 on deteriorating inventory between 2012 and 2015.

Journal	Papers
Advances in Operations Research	3
American Journal of Mathematical and Management Sciences	3
Production Engineering	5
Economic Modelling	6
International Journal of Management Science and Engineering Management	6
International Journal of Mathematics in Operational Research	5
International Journal of Operational Research	7
International Journal of Production Research	15
International Journal of Systems Science: Operations & Logistics	6
Journal of Industrial and Production Engineering	4
Journal of Industrial Engineering	6
Journal of Industrial Engineering International	5
Journal of the Operational Research Society	4
OPSEARCH	6
Optimization	5
Procedia Technology	5
The International Journal of Advanced Manufacturing Technology	4
Total papers:	95

4. Classification of inventory systems

Table 3 shows total results for classification of inventory models for perishable items based on deteriorating and demand types. References to the classification of the researched papers are presented in Table A1 (Appendix A). The classification of inventory models is described in Section 2. Depending on content, a paper may be assigned to several categories concurrently.

In Krishnamoorthy et al. (2015) items have a random common lifetime. This lifetime does not fit into the classification scheme of Bakker et al. or our work.

Table 4 shows total results for demand dependency in the current researched papers. References to the table are presented in Table A2 (Appendix A). Under 'Others-dependent' demand dependency is summarized, which does not fall into categories I–V

Table 3
Number of papers per classification category.

Deterioration	Demand	
	Deterministic	Stochastic
Fixed lifetime	(1a): 46	(1b): 82
Random lifetime	(2a): 211	(2b): 51
Sum	(1a+2a): 257	(1b+2b): 133

Table 4
Number of papers for existing demand distribution functions (I–VI).

Demand distribution functions	
(I) Uniform/constant:	53
(II) Stock-level-dependent:	44
(III) Time-varying:	75
(IV) Price-dependent:	73
(V) Age-dependent:	13
(VI) Others dependent	25

(Table A2, Appendix A). The most common demand dependencies found here are (together 17 papers): advertisement-dependent demand (Bai et al., 2015; Bhunia et al., 2015b; Chowdhury et al., 2014c; Geetha and Udayakumar, 2015a; Palanivel and Uthayakumar, 2013a, 2014; Rabbani et al., 2015; Shah et al., 2013b), quality-dependent demand (Liu et al., 2014; Qin et al., 2014; Shah et al., 2013b), and credit-period-dependent (Guchhait et al., 2015; Mahata, 2015b; Shah, 2015b; Singh et al., 2013; Wang et al., 2014; Yang et al., 2015) demand. In the remaining 8 papers in 'Others-dependent', 8 further cases of demand dependency are described: warranty- (Chung, 2013a), rebate- (Chung et al., 2013), inflation- (Jain and Aggarwal, 2012), depending on the demands of other products (Murray et al., 2012), sales team's initiative- (Palanivel and Uthayakumar, 2015a), expiration date- (Wu et al., 2015), service level- (Xiao and Xu, 2013), the current price and historical price-dependent (Xue et al., 2014).

5. Key topics review on deteriorating inventory models 2012–2015

First, we specified the key topics (Section 5.1). Following that, we sorted the current papers according to these key topics and offer here a key topics review (Section 5.2). The references for the key topics review may be found in Section 5.3.

5.1. Specifying of key topics

To specify the key topics, we first analyzed the literature reviews which were relevant for us and selectively took over the already existing key topics from these reviews. Since some topics were first added in recent years, earlier literature reviews such as Nahmias (1982) and Raafat (1991), for example, don't include many key topics. In review of Bakker et al. (2012) and Karaesmen et al. (2011) many key topics may be already found, however, we have expanded on several of these with sub topics. The result of specifying key topics is shown in Table 5. In the review of Karaesmen et al. (2011) the classification of inventory models is more detailed and key topics are more broadly based than in this work. Karaesmen et al. additionally divide inventory models in discrete and continuous review models (as did Nahmias, 1982) with details to demand, planning horizon, lead time, life time, demand distribution, etc. Since our work deals with the sorting of papers according to key topics, the details of these models are excluded.

The order of the key topics no longer corresponds to the order found in Bakker et al. (2012). The key topics have been ordered in a logical and coherent way. First, the key topics to inventory models are found (01 – 15) followed by the problem areas of these models or papers (16 – 18).

Although the earlier literature reviews do not contain newsvendor models, we have included them in our review. The newsvendor problem plays an important role in real life decision making for seasonal products and perishable goods, see for example Sachs and Minner (2014). In Sachs and Minner (2014) the usage of the newsvendor model for short shelf-life perishable

Table 5
Comparison of key topics/application context in reviews of deteriorating models.

	Key topics or application context	Nahmias (1982)	Raafat (1991)	Goyal and Giri (2001)	Lim et al. (2013)	Bakker et al. (2012)	Karaesmen et al. (2011)	This paper
01	Price increase/decrease; (dynamic) pricing; discount; advance selling	–	+	+	+	+	+	+
02	Shortages are allowed; backorder; backlogging; lost sales; service level; stockout	–	+	–	+	+	+	+
03	Two- and multi-items	+	+	–	–	+	+	+
04	Inflation and time value of money	–	+	+	+	+	–	+
05	Credit; permissible delay in payment; prepayment; advance payment; cash discount; payoff	–	+	+	–	+	–	+
06	Investments; promotion; advertising; budget	–	+	–	–	–	–	+
07	Outdating; waste; shrinkage; disposal policy	–	–	–	–	–	+	+
08	Product characteristics (imperfect, convertible, etc.); customer-specifics, -behavior, -reservations, -returns, -averse	–	–	–	–	–	+	+
09	Issuing policies (FIFO, LIFO, etc.); substitutable	+	–	–	–	–	+	+
10	Technology (RFID, TTI and others)	–	–	–	–	–	+	+
11	Transport problems (distribution, routing, location, shipment, transportation, etc.)	–	–	–	–	–	+	+
12	Rework; remanufacturing; process breakdown; imperfect process; machine interruption; preventive maintenance; reliability; inspection, etc.	–	–	–	–	–	–	+
13	Two- and multi-warehouse	–	–	+	+	+	–	+
14	Supply chain without/asymmetric information sharing; decentralized planning	+	–	–	+	+	+	+
15	Supply chain with/symmetric information sharing; centralized planning	–	–	–	+	–	+	+
16	Production planning; production; EPQ	–	+	–	+	–	+	+
17	Blood banks	–	–	–	–	–	+	+
18	Newsvendor problem	–	–	–	–	–	–	+
19	Literature reviews; papers as notes	–	–	–	–	–	–	+
20	Other topics (items and space allocation; service facilities, control and disruptions outside production; order splitting; energy consumption, etc.)	–	–	–	+	–	+	+

goods in a large European retail chain is shown. The objective of the classical newsvendor problem is to find the optimal order quantity by minimizing expected cost or maximizing expected profit. A newsvendor model is based on fixed lifetime of items (maximum lifetime is one period, as a rule). After the expiration of this lifetime (as with all other perishable items with fixed lifetime), the goods may normally no longer be sold in the market.

The key topics have the following meaning (the meaning of the well-known topics is omitted): .

06 Inventory models with joint optimization of investments, promotion or budget constraint
08 Inventory models with special product characteristics or customer specifics including behavior, reservations, returns, etc.
09 Inventory models including execution of issuance policies (FIFO, LIFO etc.) or substitutions of perishable items. For more details on this topic see for example Karaesmen et al. (2011)
11 Inventory models for distribution, routing, transportation and location problems for perishable items
12 Inventory models for perishable items with problems such as rework, process breakdown, machine interruption, preventive maintenance, etc. Most problems of production planning are found here
14 Two- and multi-echelon and multi-locations inventory models for *decentral* supply chain (asymmetric information or *without* information sharing). For more details on topics 'Multi-echelon' and 'Multi-locations' see for example, Karaesmen et al. (2011). In many current papers 'Supply chain' is given as a keyword. Li et al. (2010) even suggested classification according to the keyword 'Supply chain'. Due to this tendency, we re-named the topic 'Multi-echelon' (Bakker et al., 2012) and divided it into two areas. Topic 14 is the first and topic 15 is the second part of the division
15 One-, two- and multi-echelon and multi-locations inventory models for *central* supply chain or for supply chain *with* information sharing (all or part)
20 Other topics: A heterogeneous collection of inventory models with issues which go beyond the key topics 01 – 15

5.2. Key topics review

Table 6 shows the key topics review for current papers. The key topics themselves are printed in bold. The number of papers per (joint) key topics makes up the remaining entries. The diagonal line (underlined) of the table gives the number of papers in total which has the key topic. All entries emanate symmetrically from the diagonal line. For example, the number 01–03 (or 03–01) represents the joint key topics 'Pricing-Multi-item' and the number 05–01 (or 01–05) 'Pricing-Credit/payment'. This review shows which joint key topics do not exist and which joint key topics are often or rarely investigated. All references concerning the number of publications in Table 6 will be listed in the next section in Table B1 (Appendix B).

5.3. Key topics review references

Table B1 (Appendix B) contains references to the given key topics. For example the key topics 'Multi-item' and 'Multi-warehouse' (03 – 13) occur in papers (Das et al., 2014; Yadav et al., 2012). Because one paper can deal with several topics simultaneously, it is possible that one paper is found more than once. For example, the three joint key topics: 01, 10 and 08 are assigned to paper (Herbon et al., 2014). Thus, the paper (Herbon et al., 2014) appears in Table B1 (Appendix B) in the following rows: 01, 01–08, 08, 01–10, 08–10, 10.

6. Analysis

In the following, we discuss the results of our literature analysis. The top 3 most researched topics appear, in total, in more than half of the papers (ca. 58%) and with an additional 3 key topics, the top 6 are found in 86% of all papers (Table 7).

6.1. Pricing and markdown problems (Key topic 01)

Top 3 (71 papers) is the key topic 'Inventory models with joint pricing and markdown problems of perishables' (01–01 in Table B1). This topic is included in approximately 18% of the papers. Of those, 16 are stochastic inventory models (Chakraborty et al., 2013;

Table 6
Key topics review with the number of corresponding publications from January 2012 to December 2015. The description of key topics is found in Table 5 and literature references are found in Table B1 (Appendix B).

Key topics	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
01	71	24	3	3	7	4	1	11	3	2	2	2	0	5	8	14	0	11	1	1
02	24	157	7	20	20	6	12	10	10	0	9	7	17	8	23	35	3	19	1	7
03	3	7	20	2	4	1	1	0	3	0	5	0	2	2	2	3	0	7	0	1
04	3	20	2	35	8	1	0	2	0	0	0	3	9	2	1	7	0	0	0	0
05	7	20	4	8	81	2	0	2	1	0	4	0	12	5	22	14	0	0	3	1
06	4	6	1	1	2	17	1	1	0	0	0	0	0	1	1	4	0	1	0	1
07	1	12	1	0	0	1	21	3	6	2	4	1	0	3	5	2	5	0	0	1
08	11	10	0	2	2	1	3	40	0	1	2	1	1	2	1	5	1	9	1	5
09	3	10	3	0	1	0	6	0	19	1	1	1	0	1	4	4	4	3	0	2
10	2	0	0	0	0	0	2	1	1	8	0	0	0	1	1	0	0	1	1	1
11	2	9	5	0	4	0	4	2	1	0	34	0	0	5	23	17	0	3	0	1
12	2	7	0	3	0	0	1	1	1	0	0	20	0	1	6	18	0	0	1	0
13	0	17	2	9	12	0	0	1	0	0	0	0	28	2	1	3	0	0	0	0
14	5	8	2	2	5	1	3	2	1	1	5	1	2	23	12	9	1	2	0	0
15	8	23	2	1	22	1	5	1	4	1	23	6	1	12	78	49	2	7	0	0
16	14	35	3	7	14	4	2	5	4	0	17	18	3	9	49	103	0	10	4	4
17	0	3	0	0	0	0	5	1	4	0	0	0	0	1	2	0	10	0	5	0
18	11	19	7	0	0	1	0	9	3	1	3	0	0	2	7	10	0	48	1	4
19	1	1	0	0	3	0	0	1	0	1	0	1	0	0	0	4	5	1	17	0
20	1	7	1	0	1	1	1	5	2	1	1	0	0	0	0	4	0	4	0	26

Table 7
Top and last key topics in current papers.

Top 1	Credit and different payment problems (20% of all papers)
Top 2	Central supply chain or supply chain with information sharing (20% of all papers)
Top 3	Pricing and markdown problems (18% of all papers)
Top 4 – 6	Inflation and time value of money, product/customer specifics and transport problems. Together, these three key topics appear in ca. 28% of all papers.
Last	Technology (RFID, TTI) (2% of all papers)

Chen and Sapra, 2013; Chintapalli, 2014; Chung et al., 2015; Herbon et al., 2012a,b; Hu et al., 2015; Li et al., 2014, 2013; Maihami and Karimi, 2014; Makkar and Jha, 2012; Mohanty et al., 2015; Sainathan, 2013; Soni and Joshi, 2013; Taleizadeh et al., 2013b; Yan and Wang, 2013). The rest are deterministic models.

The perishable inventory model with pricing problem is optimized in Avinadav et al. (2013, 2014), Chang et al. (2015), Chen and Sapra (2013), Chen et al. (2014c), Chew et al. (2014), Chowdhury et al. (2014a), Chung et al. (2013), Dalfard and Nosratian (2012), Dye and Yang (2015), Li et al. (2013, 2012), Liu et al. (2014), Mahata (2015a), Mahata et al. (2015), Maihami et al. (2012), Qin et al. (2014), Wang and Huang (2014), Yan and Wang (2013), and Yang (2012a). Ouyang et al. (2014) develop an optimal order policy for announced price increase for deteriorating items with limited special order quantity.

An enterprise can offer price discount to motivate market sales, as a means of competition in markets, to deal with surplus stock and others. The perishable inventory with price markdown/discounting problems is studied in Bhunia et al. (2014b), Chakraborty et al. (2013), Chew et al. (2014), Chung et al. (2015), Jana et al. (2013), Kawakatsu (2013), Kuthambalayan et al. (2015), and Muniappan et al. (2015a). Makkar and Jha (2012) optimize quantity discounts and freight policies for multi items that are perishable in nature, which are supplied from single source to multiple destinations under fuzzy environment. Mohanty et al. (2015) explore a stochastic periodic review inventory system, wherein temporary price discount offer is taken into account. Taleizadeh et al. (2013a) also study temporary discount for perishable products.

The inventory model with two-phase or two-period pricing problem is studied in Dye (2012), Dye and Hsieh (2013b), Herbon (2015b), and Sainathan (2013). Dynamic pricing technology is studied in Herbon (2013, 2015a), Rabbani et al. (2015), Xue et al. (2014), and Zhang et al. (2015) and additionally with the use of technologies (01–10 in Table B1) such as TTI (Herbon et al., 2012a), and RFID & TTI (Herbon et al., 2014).

A joint pricing and inventory control model for deteriorating items with permissible delay in payments is found (Chang et al., 2015; Dye, 2012; Mahata, 2015a; Mahata et al., 2015; Maihami and Abadi, 2012; Soni and Joshi, 2013; Taleizadeh et al., 2013b) (01–05 in Table B1). Soni and Patel (2013) develop an inventory model for non-instantaneous deteriorating items with imprecise deterioration free time and credibility constraint. The inventory models with joint optimization of investments, promotion or budget constraint are studied in Dye and Yang (2015), Maihami and Karimi (2014), Murray et al. (2012), and Shah and Shah (2013) (01–06 in Table B1).

Perishable inventory models and pricing problems in the context of decentral supply chain are found in Chung et al. (2015), Makkar and Jha (2012), Wang and Lin (2012), Xiao and Xu (2013), and Yang et al. (2013a) (01–14 in Table B1). Wang and Lin (2012) explore a two-echelon supply chain from the perspective of the retailer and develop the optimal replenishment policy for products experiencing deterioration, continuous decrease in market demand and price changes.

Papers on this topic together with detailed description of customer or product are referenced in 01–08 in Table B1. A simulation study of the price differentiation effect in a stochastic deteriorating inventory with heterogeneous consumers is carried out in Herbon et al. (2012b). Intertemporal demand substitution joined with strategic consumer behavior is the issue in Hu et al. (2015). The paper presents a novel inventory model joined with markdown decision for perishable goods in this context. Their position is that the firm needs to make a trade-off between product spoilage and intertemporal demand substitution.

This key topic is often relevant in product context (01–16 in Table B1). For example, Kuthambalayan et al. (2015) model combines dynamic pricing and production inventory model with maximization of the total discounted profit. Their research builds on the advanced selling models to reduce the supply demand mismatch. Mahata et al. (2015) develop a perishable economic production quantity (EPQ) based model under partial trade credit policy of the retailer. Their purpose is to maximize the profit by the optimization of the selling price and replenishment time. Sarkar et al. (2013) develop a perishable inventory model for finite production rate and time dependent increasing demand, where the component cost and the selling price are considered at a continuous rate of time. They also maximize the total profit. Muniappan et al. (2015a) optimize multiples of orders and order quantity for vendor and buyer and minimize the total inventory cost.

This topic is additionally and intensively examined in 11 newsvendor models (see 01–18 in Table B1).

6.2. *Shortages and customer service level (Key topic 02)*

Approximately 40% of all models in current papers allow for shortages (key topic 02). If an item is out of stock, demand can be (partially) backordered or demand is (partially) lost. Also, (partial) backlogging of demand is possible in several inventory models for perishable items. Shortages, according to the key topics review, most commonly arise in the production context (02–16 in Table B1), but also in models with inventory and pricing (01–02 in Table B1), inflation/time value of money (02–04 in Table B1), credit/payment (02–05 in Table B1) decisions. This is a relevant issue together with supply chain as well (02–14, 02–15 in Table B1).

Backordering is considered in the works (Kouki et al., 2013a; Kumar et al., 2012a; Malligarjunan, 2014; Molana et al., 2012; Muniappan et al., 2015a; Olsson, 2014; Pando et al., 2013; Sazvar et al., 2012, 2013; Singh and Vishnoi, 2013; Shastri et al., 2013; Tai, 2013; Taleizadeh et al., 2013a; Taleizadeh, 2014a,b; Wu and Sarker, 2013; Yan et al., 2013; Yu, 2013) and (estimation) lost sales in Brito and de Almeida (2012), Chao et al. (2015), Chen et al. (2014c), Jammernegg and Kischka (2013), Kouki et al. (2015), Olsson (2014), Pal et al. (2013), Ramadhan and Simatupang (2012), Sachs and Minner (2014), Sainathan (2013), Shukla and Jharkharia (2014), and Wee and Widyadana (2013). Partial backlogging is more flexible than complete backlogging and is allowed in most papers (Ahmed et al., 2013; Agrawal et al., 2013; Annadurai, 2013a; Begum et al., 2012b; Bhunia et al., 2015a,b, 2014a,b; Bhunia and Shaikh, 2015; Brito and de Almeida, 2012; Chou and Peterson, 2015; Chowdhury et al., 2014b; Duan et al., 2012b; Dutta and Kumar, 2015; Dye, 2013; Dye and Hsieh, 2012; Geetha and Udayakumar, 2015a; Ghiami et al., 2013; Ghoreishi et al., 2013b; Goel et al., 2015; Jana et al., 2013; Kumar et al., 2013; Kumar and Singh, 2015; Lee and Dye, 2012; Lin, 2013; Lin et al., 2013; Maihami et al., 2012; Maihami and Abadi, 2012; Maihami and Karimi, 2014; Mishra and Singh, 2013; Mishra et al., 2013; Mohanty et al., 2015; Pal et al., 2013; Palanivel and Uthayakumar, 2013a,b, 2014, 2015b; Sarkar and Sarkar, 2013a; Sarkar et al., 2012; Sharma et al., 2015; Shastri et al., 2013; Singh and Sharma, 2013; Singh and Vishnoi, 2013; Singh and Pattnayak, 2014; Tan and Weng, 2013; Tyagi et al.,

2015, 2014; Valliathal and Uthayakumar, 2013a; Yang, 2012a,b; Yang and Chang, 2013; Zhao, 2014). Complete backlogging for one or multiple periods is possible in Alizadeh et al. (2014), Annadurai (2013b), Annadurai and Uthayakumar (2012), Bhunia et al. (2014b), Chao et al. (2015), Chen and Sapra (2013); Chen et al. (2014c), Duan et al. (2012b), Jayaraman et al. (2012), Muniappan et al. (2015b), Sanni and Chukwu (2013), Sharma and Rani Chaudhary (2013), Sicilia et al. (2014), Singh and Saxena (2013), Uthayakumar and Rameswari (2012), and Valliathal and Uthayakumar (2013b). (Customer) service level is taken into consideration in only a few of the inventory models, although this is very important, particularly in fresh food industries and retail (Abad, 2014; Brito and de Almeida, 2012; Chen et al., 2015; Deflem and Van Nieuwenhuyse, 2013; Dobhan and Oberlaender, 2013; Duong et al., 2015; Dye, 2013; Egri and Váncza, 2012; Ignaciuk and Bartoszewicz, 2012a–d; Jammernegg and Kischka, 2013; Ng et al., 2012; Sachs and Minner, 2014; Soysal et al., 2015; Uthayakumar and Priyan, 2013; Xiao and Xu, 2013).

6.3. Multi-item inventory models (Key topic 03)

The perishable inventory models with two- and multi-items (key topic 03) are most frequently found jointly with transport (03–11 in Table B1) and newsvendor (03–18 in Table B1) problems. The remaining papers with multi-item inventory models are (Chakraborty et al., 2013; Das et al., 2014; Duong et al., 2015; Ghosh et al., 2015; Jain et al., 2014; Jiangtao et al., 2013; Purohit and Rathore, 2012; Yadav et al., 2012; Yadavalli et al., 2015; Yan et al., 2013). The number of multi-item inventory models is limited, in comparison to single perishable item models. This imbalance is due mainly to the complexity of multi-item models. Duong et al. (2015) propose a solution for the problem of inventory management in a two-echelon model for perishable and substitutable products with multi-period lifetime. Their model is made more realistic by incorporating multiple inventory characteristics and allowing improvement with performance metrics. Jain et al. (2014) present a study with an inventory system for perishable multi-items having stock dependent demand rates under an inflationary environment of the market. Yadav et al. (2012) develop an inventory model for deteriorating items using a two-warehouse system in a fuzzy environment. Yadavalli et al. (2015) consider a disaster inventory system for two substitutable perishable products. They developed a continuous-review analysis of the disaster inventory.

6.4. Inflation and time value of money (Key topic 04)

Inclusion of inflation and time value of money in an inventory model for perishable items can improve the solution of the optimization problem (04–04 in Table B1). Consideration of inflation in two-warehouses joined with an inventory model for perishable items is studied in Bhunia et al. (2015a), Das et al. (2012), Kumar et al. (2012a,b, 2013), Palanivel and Uthayakumar (2015b), Yadav et al. (2012), Yang (2012b), and Yang and Chang (2013) (04–13 in Table B1).

Ghoreishi et al. (2013a) develop an EPQ inventory model for non-instantaneous deteriorating items under inflationary conditions with consideration of customer returns as a function of price and demand. The effect of inflation together with pricing and inventory control for deteriorating items is studied in Ghoreishi et al. (2013a,b) and Jana et al. (2013) (01–04 in Table B1). Jaggi et al. (2013) investigate the impact of defective items on retailer's ordering policy for deteriorating items under inflation when both demand and price vary with the passage of time. Taleizadeh and Nematollahi (2014) investigate the effects of time value of money and inflation on the optimal ordering policy in an inventory control system.

Several papers consider the combined effect of inflation, deterioration and trade credit policy on inventory models (Jain and Aggarwal, 2012; Muniappan et al., 2015b; Palanivel and Uthayakumar, 2015b; Pareek and Dhaka, 2015; Taleizadeh and Nematollahi, 2014; Yadav et al., 2013; Yang et al., 2013b; Yang and Chang, 2013) (04–05 in Table B1). Jain and Aggarwal (2012) use a discounted cash flow approach. Pareek and Dhaka (2015) develop a fuzzy inventory model for deteriorating items given a situation in which a supplier offers the purchaser some credit, proportional to the quantity ordered by purchaser.

6.5. Credit and different payment problems (Key topic 05)

The most (Top 1) commonly addressed key topic is 'Inventory models with credit option and different payment problems' (05–05 in Table B1). This makes up 20% of all publications (81 papers) over the last years. This key topic is often relevant in product context (03–16 in Table B1), in supply chain (05–14, 05–15 in Table B1) and is intensively examined in two-warehouse inventory models (05–13 in Table B1).

A profitable perishable inventory model may include a permissible delay in payments which has been agreed upon. Generally, if a perishable product is bought by a customer, the buyer should pay the outstanding purchase costs immediately. However, if the seller offers the buyer a certain delay in payment of the purchasing cost (called a trade credit period) then the seller has the expectation that he can sell more items to the buyer within the delay period. This offer from the seller to the buyer is the so-called trade credit or delay in payment. Depending on the trade-credit policy, several inventory models with permissible delay in payments are discussed in the literature. In taking advantage of trade credit, the buyer reduces his costs and is inspired to order more perishable items. Therefore, the buyer has to balance between their own revenue and costs.

The cascading usage of trade credit policies from supplier to buyer and from buyer to its customers is known as two-level trade credit. This approach is studied in Chung (2013b), Chung and Cárdenas-Barrón (2013), Chung et al. (2014), Duan et al. (2012a), Dye (2012), Guchhait et al. (2014, 2015), Jiangtao et al. (2013), Mahata (2012), Shah (2015a), Shah et al. (2014, 2013a), Singh and Sharma (2013); Singh et al. (2013), Soni (2013a,b); Soni and Joshi (2013), Thangam (2012), Urban (2012), and Wu et al. (2014a). The difference in these works arises in restrictions for storage space, formulation of demand function (stock-dependent, price-dependent demand etc.) and others.

Recently, several works have studied the effect of partial trade credit policy on the inventory models (Annadurai and Uthayakumar, 2012; Chen et al., 2014b; Guchhait et al., 2013b, 2015; Mahata, 2012, 2015a; Mahata et al., 2015; Majumder et al., 2015; Soni and Joshi, 2013; Thangam, 2012; Ting, 2015; Wu and Chan, 2014). Taleizadeh (2014b) develops an economic order quantity model for a deteriorating product with partial backordering and partial (multiple) consecutive prepayments.

Prepayment joined with an inventory model for deteriorating items is studied in Taleizadeh (2014a,b); Taleizadeh et al. (2013b), and Thangam (2012). For example, retailers can require the buyer to pay all or a fraction of the purchasing costs in advance, or allow them to divide the prepayment into several equal-sized parts. Taleizadeh (2014a) develop an economic order quantity (EOQ) model for a deteriorating item with and without shortage under consecutive prepayments. Taleizadeh et al. (2013b) revisit a fuzzy rough economic order quantity model for deteriorating items, considering quantity discount and prepayment. They use the meta heuristic algorithm BCO (Bees Colony Optimization). Taleizadeh (2014b) focuses on an economic order quantity model with partial

backordering for an evaporating product when a fraction of the purchasing cost must be prepaid. This real case study is a gasoline station. Thangam (2012) studies price discounting and lot-sizing policies for perishable items in a supply chain under an advance payment scheme and two-echelon trade credits. The paper considers a supply chain where the supplier provides the retailer a full trade credit period for payments, whereas the retailer offers the partial trade credit to his customers. The priority will be given first to the customers, if these use an advance payment scheme.

For example, in competitive markets many enterprises offer trade credits for products to increase sales. Trade credit calculation is based on discounted cash flow analysis (with consideration of the time value of money on the purchase cost). This problem together with the inventory model for perishable items is dealt with in Chen and Teng (2015), Chung et al. (2012), Jain and Aggarwal (2012), Pareek and Dhaka (2015), Shah (2015b), and Shah and Patel (2012). Pareek and Dhaka (2015) deal with a fuzzy inventory model for deteriorating items in a situation in which a supplier offers the purchaser some credit, proportional to the quantity ordered by purchaser. Shah (2015b) analyzes ordering and credit policies for a retailer, if a supplier offers its retailer either a cash discount or a fixed credit period. But this is only applicable if the order quantity is greater than or equal to the regular order policy. In this case, the retailer offers credit period to its customer in order to increase the demand. Chen and Teng (2015) use discounted cash flow analysis on revenue and costs with consideration of expiration date for a deteriorating item. The expiration date is an important factor in the consumer's purchase decision for deteriorating items.

Multi-item inventory models with trade credit option are investigated in Chakraborty et al. (2015), Das et al. (2014), Jiangtao et al. (2013), and Uthayakumar and Priyan (2013) (03–05 in Table B1). Inventory models with trade credit option and transport problems are studied in Chakraborty et al. (2015), Shah (2015a), Tsao (2014), and Uthayakumar and Priyan (2013) (03–11 in Table B1). 20 papers out of this key topic 05 allow for shortages (02–05 in Table B1).

Stochastic inventory models with fuzzy random environments are rarely joined with trade credit option (Guchhait et al., 2014; Majumder et al., 2015; Shabani et al., 2015; Shah et al., 2013a; Soni and Joshi, 2013; Taleizadeh et al., 2013b; Uthayakumar and Priyan, 2013; Xu, 2014). Guchhait et al. (2014) assume that the planning horizon of business is random. Majumder et al. (2015) develop an EPQ for deteriorating items under partial trade credit policy with crisp and fuzzy demand. For fuzzy demand there is a triangular fuzzy number. Shabani et al. (2015) propose a new two-warehouse inventory model with fuzzy deterioration rate and fuzzy demand rate under conditionally permissible delay in payment. Shah et al. (2013a) study a deteriorating inventory model with finite production rate and two-levels of credit financing for stochastic demand. Soni and Joshi (2013) study a generalized economic order quantity and use a two-level trade credit policy in a fuzzy sense.

6.6. Investments, promotion or budget constraint (Key topic 06)

This key topic includes 17 papers all together (06–06 in Table B1). In the real-life market, an enterprise can make capital investment in equipment, production processes, etc. These investments help to reduce or remove some of the linked problems. Preservation technology can be used to reduce the deterioration rate over time, for example. The finding of an optimal order policy and preservation technology investment strategy is the objective under minimizing the total cost or maximizing the total profit over a planning horizon. Several works study this optimization problem (Chen and Dye, 2013; Dye, 2013; Dye and Hsieh, 2012; Dye and Yang, 2015; He and Huang, 2013; Hsieh and Dye, 2013; Lee and Dye, 2012; Shah and Shah, 2013; Singh and Sharma, 2013; Tayal et al., 2014b; Yang et al., 2015). Chen and Dye (2013) and Lee and Dye (2012) formulate a deteriorating inventory model by allowing preservation technology cost as a decision variable in conjunction with replacement policy.

Promotional activity of enterprises has become prevalent in the business world. Promotional efforts impact the replenishment policy and the price of goods. The problem of order decision for deteriorating items subject to promotional effort is considered in Maihami and Karimi (2014), Palanivel and Uthayakumar (2015a), and Pattnaik (2012b).

Chaudhary et al. (2015) develop a supply chain model for deteriorating items with imperfect production process with stochastic demand rate under budget constraint.

6.7. Outdating, waste or shrinkage (Key topic 07)

21 papers emphasize the issues outdating, waste or shrinkage with inventory models for perishable goods (07–07 in Table B1). The five papers specialized in blood banks are (Civelek et al., 2015; Duan and Liao, 2014; Gunpinar and Centeno, 2015; Haijema, 2013, 2014). Haijema (2014) develops optimal ordering, issuance and disposal policies for inventory management of perishable products. The author finds out that under LIFO issuance, an optimal disposal policy has significant impact when orders are set by a base stock policy, but not under optimal stock-age dependent ordering. Although the withdrawal policy is important in the context of outdating/waste, only 6 works address this in more detail (Civelek et al., 2015; Duan and Liao, 2014; Duong et al., 2015; Haijema, 2013, 2014; Kouki et al., 2013b) (07–09 in Table B1).

Shrinkage and misplacement inventory problems of perishable items are studied in Fan et al. (2015). They focus on the impact of RFID technology adoption on supply chain decisions in the Internet of Things.

Circa 50% of papers within the key topic 07 allow for shortages (02–07 in Table B1). 8 papers study the outdating/waste problematic in supply chains (07–14 and 07–15 in Table B1).

6.8. Product characteristics or customer specifics including behavior, reservations, returns, etc. (Key topic 08)

In 40 inventory models (10% of all papers) for perishable goods, explicit consideration is given to the specifics of products, customer details or special features of the customer replenishment process (08–08 in Table B1).

Specifics of products are handled in Gunpinar and Centeno (2015), He and Huang (2013), Jaggi et al. (2015), Moussawi-Haidar et al. (2014), Rijpkemaa et al. (2014), Shukla and Khedlekar (2015), and Yang and Tseng (2015). Information on customers is mostly considered in the papers (Herbon, 2015a; Herbon et al., 2014, 2012b; Kuthambalayan et al., 2015; Mahmoodi et al., 2015; Malligarjunan, 2014; Tai, 2015; Xu et al., 2014). In practice, customers may make reservations and cancel these orders before receiving them. This specific issue is studied in Dye and Hsieh (2013b), Krishnamoorthy et al. (2015). Chen and Zhou (2014) and Ghoreishi et al. (2013a, 2013b) consider customer returns in the inventory models for perishable items. Influence of consumer purchasing behavior on the production planning of perishable food is studied in Amorim et al. (2013). Wu and Chan (2014) establish optimal lot-sizing policies for a retailer who sells a deteriorating item to credit-risk customers by offering partial trade credit to reduce his/her risk.

Several newsvendor models include such descriptions specifically (08–18 in Table B1). Effects of a risk-averse newsvendor are studied in Kazaz and Webster (2015), Qiu et al. (2014), Sun et al. (2013), Wu et al. (2013), and Xu et al. (2015), and loss-averse

newsvendors are considered in Baron et al. (2015) and Chen and Zhou (2014).

6.9. Issue policies (FIFO, LIFO, etc.) or substitutions of perishable items (Key topic 09)

Current papers on these key topics are summarized in 09–09 in Table B1. First-in-first-out (FIFO) depletion policy allows for withdrawal of the oldest items first and last-in-first-out (LIFO) allows for the newest units first. The FIFO policy is always optimal (Nahmias, 1982). FIFO policy is relevant in healthcare whereas the LIFO policy and a combination of these policies are more realistic in food retail, for example. Chen and Sapra (2013), Haijema (2014), Lee et al. (2014), Önal et al. (2015), Shukla and Jharkharia (2014), and Wee and Widyadana (2013) deal with the topic. Shukla and Jharkharia (2014) present an inventory model for managing deteriorating agri-fresh produce with three inventory issue policies FIFO, LIFO, and random retrieval (RR).

In inventory management, demand for a particular product during its stock-out period may be substituted with another available similar product in the inventory. Chen et al. (2015), Chew et al. (2014), Civelek et al. (2015), Duan and Liao (2014), Duong et al. (2015), Sainathan (2013), and Yadavalli et al. (2015) deal with the topic. Product substitution for the newsvendor problem is studied in Deflem and Van Nieuwenhuyse (2013) and Ng et al. (2012).

6.10. Advances in technology (RFID, TTI) corresponding to inventory models (Key topic 10)

There are very few papers (2%) on advances in technology (RFID, TTI) jointly with inventory models for perishable goods (10–10 in Table B1). Radio Frequency Identification (RFID) technology is regarded as a promising solution for inventory inaccuracy. This technology is used in retail, healthcare and medical industries, sea logistics etc. Fan et al. (2014) consider the situation of a retailer subject to inventory inaccuracies stemming from shrinkage problems. They apply a newsvendor model to analyze how to reduce inventory shrinkage problems by deploying RFID. Further work on the topic RFID is found in Fan et al. (2015), Lim et al. (2013), and Piramuthu and Zhou (2013).

Generally, perishable items with an expiry date are indicated with a label. Alternatively, the freshness of perishable items can be determined with TTI (time-temperature indicator) technology. A TTI tag is placed on a perishable item and the information of TTI can be optionally monitored per RFID. Inventory models with TTI technology are studied in Herbon et al. (2012a, 2014) and Kouki et al. (2013b) and TTI and RFID are taken into consideration in Herbon et al. (2014) and Ketzenberg et al. (2014). Herbon et al. (2012a, 2014) explore the TTI and RFID technologies with the pricing problem (01–10 in Table B1).

6.11. Distribution, routing, transportation and location problems (Key topic 11)

Transport inventory problems are of great significance in supply chain management. They may be classified in four areas: distribution, routing, location and transportation problems. Current papers on this key topic are summarized in 11–11 in Table B1. The 28 papers on transport problems are considered mainly in link with supply chains (11–14, 11–15 in Table B1). 17 papers are provided in production context (11–16 in Table B1) and Table 3 works present newsvendor models (11–18 in Table B1).

In general, distribution networks and centers handle the distribution and storage of products. However, the distribution and storage of perishable items normally requires consideration of the limited lifetime of items. The distribution inventory problem is studied in Belo-Filho et al. (2015), Cai et al. (2013), Diabat et al. (2014), Firoozi et al. (2013, 2014), Gaggero and Tonelli (2015), Hanasusanto et al. (2014), Lee and Kim (2014), Makkar and Jha (2012), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Seyedhosseini and Ghoreyshi (2015a), Seyedhosseini and Ghoreyshi (2014a,b, 2015b), Tsao (2014), and Uthayakumar and Priyan (2013).

A key decision factor in the distribution channel is that the connections in supply chains have the lowest-possible costs. The integration of inventory control and vehicle routing yields a complex optimization problem called inventory routing problem (IRP) whose aim is to minimize the total inventory and transportation cost. Belo-Filho et al. (2015), Coelho and Laporte (2014), Diabat et al. (2014), Jia et al. (2014), Mirzaei and Seifi (2015), Seyedhosseini and Ghoreyshi (2014a,b), and Soysal et al. (2015) deal with the inventory routing problem.

Location decisions are significant in supply chain, because decreasing the number of warehouses in a supply chain leads to reduction of inventory costs, but increases transportation costs from warehouse to customer. This topic is relevant in works (Dobhan and Oberlaender, 2013; Drezner and Scott, 2013; Firoozi et al., 2013, 2014; Tsao, 2014).

Chakraborty et al. (2015), Giri and Sharma (2013), Gumasta et al. (2012), Leśniewski and Bartoszewicz (2013, 2014), Makkar and Jha (2012), Rijpkemaa et al. (2014), Sazvar et al. (2014), Taleizadeh and Rasuli-baghban (2015), Wang et al. (2012), and Wu and Sarker (2013) optimize order policy together with shipment or transportation problems. The transportation problem considers only transportation costs (Chakraborty et al., 2015) or the optimal combination of number of vehicles and their carrying capacity (Gumasta et al., 2012) and the like. Gumasta et al. (2012) develop the inventory model joining the transportation system with time varying demand and two types of customers for different perishable goods to simultaneously maximize the revenue and minimize transportation and inventory costs. The shipment problem is studied in Giri and Sharma (2013), Shah (2015a), and Taleizadeh and Rasuli-baghban (2015).

6.12. Rework, process breakdown, machine interruption, preventive maintenance, etc. (Key topic 12)

18 of 20 papers (see 12–12 Table B1) on these topics linked to production context are (12–16 in Table B1). In production, perfect and imperfect items can be produced. The imperfect items can be reworked to be like the original product. Inventory models for deteriorating items which are reworked or remanufactured are looked at in Guchhait et al. (2013a), Li et al. (2015), Muniappan et al. (2015a), Sarkar and Sarkar (2013c), Sarker and Wu (2015), Shah et al. (2012), Singh and Saxena (2013); Singh and Singh (2013), Tai (2013), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a), and Yang et al. (2013a). Guchhait et al. (2013a) and Sarkar and Sarkar (2013c) additionally explore the use of the reliability parameter of production facilities and link the reliability parameter with costs for development, material and production.

Chung (2013a) investigates imperfect process and demand effects on inspection scheduling. The author developed an integrated two-stage production inventory deteriorating model for replenishment policy with consideration of inspection cost.

Jiang et al. (2015) and Widyadana and Wee (2012b) develop production inventory models for deteriorating items with consideration of machine breakdown and preventive maintenance. Models with stochastic preventive maintenance time and rework processes are more realistic (Wee and Widyadana, 2012, 2013; Widyadana and Wee, 2012b). A penalty cost for process deterioration and process breakdown is considered in Jeang (2012).

6.13. Two- and multi-warehouses (Key topic 13)

In the key topic two- and multi-warehouses 28 new papers exist (13–13 Table B1). The most commonly joined topics are inflation (9 papers, see 04–13 Table B1) and trade credit (12 papers, see 05–13 Table B1).

The classical inventory models are mainly developed for the single own warehouse (OW). But its limited capacity may lead to the need to rent a second warehouse (RW). RW is located at some distance from OW. In real-life situations deterioration rates play a large role, as do inventory holding costs of OW and RW, distance between OW and RW, transport costs, demand dependency, as well as size, storage capacity and others parameters.

Only one work is dedicated to the problem of multi-warehouses (Das et al., 2014). They develop a multi-item multi-warehouse inventory model for deteriorating items for *m* secondary warehouses (SWs) and *one* primary warehouse (PW) under permissible delay in payment. The demand of the items is dependent on selling price and stock-level at the primary warehouse. In the model, the stocks of SWs are transferred to PW. The distance from PW to SWs has direct influence on transportation cost, and the holding cost of an item in SWs has a reverse effect with the distance. Their inventory model is solved via contractive mapping genetic algorithm and particle swarm optimization. All other works study two-warehouse inventory models. Only 3 papers are linked with production context (Chung, 2013b; Singh and Vishnoi, 2013; Yu et al., 2014) (13–16 Table B1).

6.14. Decentral supply chain and supply chain without information sharing (Key topic 14)

Decentral supply chain and supply chain without information sharing are summarized in 14–14 Table B1. These include 23 papers (6% of all papers). This is three-times fewer papers in comparison with publications on (central) supply chain with information sharing (15–15 Table B1). Together, central and decentral supply chains are investigated in one of four papers (26% of all papers).

In 12 papers both design alternatives (central/decentral or with/without information sharing) of supply chains are studied (Arianezhad et al., 2013; Cai et al., 2013; Chakraborty et al., 2015; Dobhan and Oberlaender, 2013; Duan and Liao, 2013; Duan et al., 2012a; Fan et al., 2015; Giri and Bardhan, 2012; Gunpinar and Centeno, 2015; Wu and Zhao, 2014; Xiao and Xu, 2013; Yang et al., 2013a) (14–15 Table B1). 9 papers deal with production context (14–16 Table B1) and a further major aggregation of papers (5 papers each) is linked with topics (01–14, 05–14, 11–14 Table B1).

Producers receive raw materials from suppliers and make them into finished products. These finished products are sold by the producers to retailers and the retailers sell them to consumers. When a product moves through more than one stage before reaching the final consumer, the result is a multi-echelon inventory system. For example, a two-echelon inventory model can be considered a supply chain with a single supplier and a single buyer. The term multi-echelon inventory model is used often in literature in such cases as a single supplier and a multi-buyer, for example. Two-echelon supply chains are studied under key topic 14 (Arianezhad et al., 2013; Duan et al., 2012a; Ghiami et al., 2013; Tayal et al., 2014b; Wang and Lin, 2012; Wu and Zhao, 2014; Zhou et al., 2012). A three-echelon supply chain inventory model for deteriorating items is explored in Cai et al. (2013) and Kumar et al. (2012b). Perishable inventory models for multi-echelon supply chains are developed in Dobhan and Oberlaender (2013), Duan and Liao (2013), Ignaciuk and Bartoszewicz (2012d), Makkar and Jha (2012), and Yang et al. (2013a). In Ignaciuk and Bartoszewicz (2012d) perishable goods are replenished from multiple supply sources characterized by different lead times. In Yang et al. (2013a), the logistics system includes a manufacturer and multi-retailer. In Makkar and Jha (2012) supply is from a single source to multiple destinations under fuzzy environment. Duan and Liao (2013) consider a class of order-up-to policies for handling highly perishable products in a single-vendor multi-buyer supply chain.

6.15. Central supply chain or supply chain with information sharing (Key topic 15)

A large number of central/with information sharing multi-echelon inventory models have been developed in the last years. Top 2 (78 papers, 20% of all papers) is represented in the broad topic area central or integrated supply chain with information sharing (15–15 Table B1). More than half of these papers (49 papers) deal with a production context (15–16 Table B1). In these models, the joint key topics include pricing (8 papers, 01–15 Table B1), trade credit (22 papers, 05–15 Table B1) and transport decisions (23 papers, 11–15 Table B1) are often researched. 8 newsvendor models have been developed for these supply chains (Bloomfield and Kulp, 2013; Dobhan and Oberlaender, 2013; Drezner and Scott, 2013; Jeong and Leon, 2012; Jörnsten et al., 2012; Luo et al., 2012; Roy et al., 2012) (15–18 Table B1).

Central supply chain inventory models for deteriorating items are studied in Dobhan and Oberlaender (2013), Duan and Liao (2013), Duan et al. (2012a), Fan et al. (2015), Giri and Bardhan (2012), Sazvar et al. (2014), Xiao and Xu (2013), and Yang et al. (2013a), where (Dobhan and Oberlaender, 2013; Duan and Liao, 2013; Duan et al., 2012a; Giri and Bardhan, 2012; Xiao and Xu, 2013) explore both central and decentral approaches.

Two-echelon supply chain inventory models for deteriorating items are explored in Arianezhad et al. (2013), Bai et al. (2015), Chakraborty et al. (2015), Duan et al. (2012a), Giri and Sharma (2013), Jia et al. (2014), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Sarkar (2013), Sazvar et al. (2014), Taleizadeh et al. (2015), Tat et al. (2013), Wu and Zhao (2014), and Yu et al. (2013a). Three-echelon supply chain inventory models for deteriorating items are explored in Cai et al. (2013), Chung et al. (2014), Goel et al. (2015), Roy et al. (2012), Shah (2015a), and Taleizadeh and Rasuli-baghban (2015). Multi-echelon supply chain inventory models are developed in Cai et al. (2013), Duan and Liao (2013), Duong et al. (2015), Ghiami and Williams (2015), Jeong and Leon (2012), Sarker and Wu (2015), Seyedhosseini and Ghoreyshi (2015a), Shastri et al. (2013), Taleizadeh and Rasuli-baghban (2015), Wu and Sarker (2013), and Yang et al. (2013a). The planning problem is complex when the number of locations exceeds two. Dobhan and Oberlaender (2013) present a newsvendor model dealing with this problem.

6.16. Production context (Key topic 16)

Circa 26% of all papers (103 papers) originated in the context of production (16–16 Table B1). 58 papers added the topic of supply chains (14–16, 15–16 Table B1), 18 papers added the topic imperfect production (12–16 Table B1), 17 papers included transport problems (11–16 Table B1), and 14 papers additionally addressed the topics pricing and trade credit (01–16, 05–16 Table B1). 10 of the papers are newsvendor models (16–18 Table B1).

6.17. Blood banks (Key topic 17)

Blood is not an ordinary perishable item. The supply of donor blood is fairly irregular and the demand for blood products is stochastic (Beliën and Forcé, 2012). Matching supply and demand in an efficient manner is not straightforward. In the area blood banks we referenced 10 papers (17–17 Table B1). There is

noticeably more effort to minimize outdating/waste (07–17 Table B1) than in the areas of retail and production, which is natural in the case of very costly perishable items. The topic outdating/waste is closely joined with the topic issuing policies (09–17 Table B1), thus we have here a relatively high number of papers on key topics 09–17.

6.18. Newsvendor (Key topic 18)

Although the newsvendor model (18–18 Table B1) is a very well-known and long-since investigated problem, it is still currently much researched in 48 papers (12% all papers). The newsvendor problem for example, is expanded by: multi-period (Egri and Váncza, 2012; Kim et al., 2015); multi-item (Abdel-Malek and Otegbeye, 2013; Deflem and Van Nieuwenhuyse, 2013; Ding, 2013; Ding and Yuan, 2014; Hanasusanto et al., 2014; Murray et al., 2012); multi-location (Dobhan and Oberlaender, 2013). Capacitated newsvendor is investigated in Abdel-Malek and Otegbeye (2013), Kuthambalayan et al. (2015), and Murray et al. (2012) and a data-driven newsvendor problem is addressed in Levi et al. (2015) and Sachs and Minner (2014).

6.19. Papers as notes (Key topic 19)

We count four new literature reviews in the research area of inventory models for perishable items (Beliën and Forcé, 2012; Lim et al., 2013; Stanger et al., 2012a,b). The remaining 13 papers are notes, comments, responses, etc. to published works on inventory models for perishable items (19–19 Table B1).

6.20. Others topics (Key topic 20)

26 papers (6% of all papers) contain rarer topics, which are consolidated under key topic 20 (20–20 Table B1). For example, papers with the following content are found here: Disney and Warburton (2012) illustrate the use of the Laplace transform to conduct 'Net present value' analysis of the EOQ model for perishable inventory and they reflect upon the pedagogical aspects of using the Lambert W function; Graczová and Jacko (2014) introduce the knapsack problem for perishable inventories concerning the optimal dynamic allocation of a collection of products to a limited knapsack; Maddah et al. (2014) consider the common framework of a reserve stock that is utilized only when a supply interruption occurs randomly and infrequently; Sazvar et al. (2013) study an order splitting policy for a retailer that sells a deteriorating product; Soysal et al. (2015) present a multi-period IRP model that includes truck load dependent distribution costs for a comprehensive evaluation of CO_2 emission and fuel consumption, perishability, and a service level constraint for meeting uncertain demand.

7. Future research topics

In this section we give our suggestions for some future research topics. Some of our suggestions are in accordance with the future research directions presented by Karaesmen et al. (2011) and Bakker et al. (2012). Other suggestions are new or additional to the already shown research directions.

The development of more stochastic perishable inventory models already motivated Goyal and Giri in their review (Goyal and Giri, 2001) 15 years ago. Although the number of stochastic inventory models has continued to increase in the last years, no breakthrough has occurred. There should be more stochastic inventory models in future research, because they correspond more accurately with real-world conditions. In particular, scenario-tree-based (Birge and Louveaux, 2011) multi-stage stochastic programming is very seldom, although such models in the context of production of perishable items are very promising for the future due to the robust solutions. The stochastic programming can improve the results, because in general, an approximation of the objective function is more possible with a scenario-tree approach as with an expected value (Shapiro and Philpott, 2007).

The number of publications regarding the multi-item perishable inventory model has increased in the last years. Nonetheless, there are still many open relevant questions which have not yet been investigated in the multi-item perishable inventory models. For example, capital investments are normally needed for multiple products, however, most inventory models are modeled for a single-item. Also inventory models which consider investments for perishable and non-perishable products are possible in real-world situations. Future perishable inventory models can be developed for such different products simultaneously (03–06 Table 6). In the production of perishable items, several problems may arise. Handling the problems as rework, process breakdown, machine interruption, etc. is relative to a product, although these problems can apply for multiple products simultaneously. Future models should consider more situations of practical relevance (for example multi-item perishable products, stochastic demand, etc.) in the area of imperfect production (12–12 Table 6). The aim of the development of the (future) perishable inventory models is to model the investigated real mini-world as accurately as possible and to deliver an optimal solution for the (joint) decision problems. Therefore, ideally, the majority of inventory models should be developed for multiple products, because they are more realistic.

The combined optimization of perishable inventory and transport problems is of great significance in supply chain management. The existing works on this topic have shown that such combined models can lead to total cost minimization in the supply chain or in an enterprise. For two- and multi-warehouses such joint models are important, because the transport cost reduction is especially important in the case of multiple warehouses (11–13 Table 6). The linked optimization of lot sizing and transport problems may also bring benefits in the case of imperfect production processes, etc. Such studies may be important for the future and should be continued (11–12 Table 6). In Nahmias (2011, p. 20) inventory models are described in which perishable and non-perishable products are considered together. The application of such models is found primarily with blood banks. However, such inventory models, linked with transport problems, are also interesting for grocery retail, because here as well perishable and non-perishable products may be part of an order decision and may be delivered together.

Raafat already called for the development of inventory models with complicated deterioration functions for perishable items with random lifetime in his review (Raafat, 1991) 25 years ago, which can better map the real deterioration process. The sample functions are still standard. Future models could be developed with more realistic deterioration functions.

Demand is typically modeled on a daily or weekly basis (macro-period). In the real-world however, the demand may also be satisfied more often (for example in grocery retail). Although a multiple-times-daily satisfaction of demand exists in the real-world, there are hardly any perishable inventory models which provide the demand modeled in micro-periods (in smaller time units than a day or a week). That may make sense when making decisions, if for example a multiple-times-daily planning is carried out or if a once daily/weekly planning should additionally be performed. In future research more micro-period inventory models could be studied. In particular for quickly perishable products, they can allow for a finer planning and may bring additional

benefits for the enterprise (cost minimization, waste reduction, resource optimization, etc.).

The food supply chains are faced with the challenge of being sustainable and environmentally friendly. Soysal et al. (2012) present the first literature review on sustainable food logistics management. The topic of sustainability must be more focused on in future research with perishable inventory models. The problem of waste reduction belongs, for example, to sustainability. In view of high waste amounts in the food supply chain worldwide (Kranert et al., 2012), the goal of waste reduction should be targeted in retail and production as well (07–07 Table 6). In the work of van Donselaar and Broekmeulen (2012a) it was already shown that a strong relation exists between customer service level, safety stock and outdating. In regard to this relation, hardly any perishable inventory models on the basis of micro-periods exist, which would allow for a finer planning in day times (micro-periods) with a lower level of safety stock while maintaining the same high level of customer service. Typically, the inventory models deal with the planning on a daily basis and the safety stock is therefore significantly higher.

In most perishable inventory models either the FIFO or the LIFO issue policy is possible, although in the real-world (for example in grocery retail) a mix of both policies is commonly used. Thus, more future models could be developed in which both issue policies are considered together (09–09 Table 6).

RFID- and TTI-Technologies are only slowly establishing themselves in grocery retail, thus there are relatively few papers regarding these topics (Lim et al., 2013). Today only these two technologies exist which may be used for perishable items. In the European Union, there are efforts and plans to replace the best-before date with the TTI labels (Kranert et al., 2012). Interruption of the cold chain can lead to premature spoilage of the perishable items, however, with compliant cooling or undercooling, the perishable items may have a longer life than that which is shown on the best-before date label. TTI labels show in contrast to best-before date labels the actual freshness of the goods, but the TTI labels bring an additional uncertainty for the producer and retailer of perishable products. The uncertainty relating to the life time of perishable products with the use of TTI technology has not been investigated enough to date, although this research experience can be important in the future for European countries (09–09 Table 6).

Credits and investments play a practical role linked with perishable inventory models and RFID technology; however studies are lacking for these combined problems (05–10, 06–10 Table 6). The currently existing inventory models with RFID- and TTI-Technologies do not consider multi-items (03–10 Table 6), although such models are relevant, because these technologies are normally used for multiple products in an enterprise.

Although in real retail situations with and without closed days exist, the perishable inventory models do not take this into account. In the case of quickly perishable items however, each day plays a role. Future inventory models for quickly perishable items could be better suited for retail situations with and without closed days.

8. Conclusion

The literature for mathematical inventory models of perishable items has already been documented up to the year 2011. Our primary goal was to bring together all the publications that existed in this area from January 2012 to December 2015. In this paper we have provided an up-to-date review of 393 papers.

The number of academic publications on inventory models of deteriorating items has increased greatly over the last years and there are more and more new and joint topics in academic publications. For this reason, we have extended the number of key topics and created a key topics review. These papers were first classified according to demand and deterioration and then sorted according to key topics. Our key topics review enables a simple and quick search for publications on given key topics. Furthermore, this review shows the current focuses in this field of research.

The classification and sorting of models is based on the work of Bakker et al. (2012), which we have expanded on in this work. Bakker et al. continue the classification of inventory models for perishable items according to the work of Goyal and Giri (2001). Our work contains no subcategories for deterministic demand as in the above mentioned literature reviews (Goyal and Giri, 2001; Bakker et al., 2012). These subcategories were modified to categories for deterministic and stochastic demand (see Section 2).

Much has changed in comparison to the research activities of the last literature review of Bakker et al. (2012). In current papers there are nine new types of demand dependencies (warranty-dependent, advertisement-dependent, rebate-dependent demand and others) and demand is more and more frequently depicted as a multivariate function. The number of inventory models for supply chain with information sharing, two-warehouse, multi-item has also increased. Specific characteristics of customer- or products (key topic 08) are often taken into consideration in the models as well. Many models are being developed for the production field, where the problems of imperfect production process, interruptions and others are being dealt with even more than before (key topic 12).

This illustrates a present dynamic in this research area and shows that many more new works could arise here. Thus, the research in this area is nowhere near being exhausted, but rather, on the one hand, is more focused, and on the other hand, broader in that it includes new problems in trade, production, etc. Literature reviews will continue to be necessary in the future, as may be seen by these research activities on the whole.

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Appendix A. Classification of inventory models for perishable items

Table A1
Classification category with corresponding references.

	Deterioration	Demand	
		Deterministic	Stochastic
	Fixed lifetime	(1a): 46	(1b): 82
	Random lifetime	(2a): 211	(2b): 51
	Sum	(1a+2a): 257	(1b+2b): 133
(1a)	Amorim et al. (2013), Atan and Rousseau (2015), Avinadav et al. (2013, 2014), Belo-Filho et al. (2015), Chen and Teng (2014), Chen et al. (2014c), Chew et al. (2014), Duan et al. (2012a), Firoozi et al. (2014), Graczová and Jacko (2014), Guchhait et al. (2013a), Gunpinar and Centeno (2015), He and Huang (2013), Herbon (2015a,b, 2013,2014), Jammernegg and Kischka (2013), Jia et al. (2014), Kumar Sett et al. (2012), Lee et al. (2014), Li et al. (2012), Liu et al. (2014), Mahata (2015a), Muniappan et al. (2015a), Önal et al. (2015), Piramuthu and Zhou (2013), Sarkar (2012), Sarkar et al. (2014), Sarkar and Sarkar (2013a), Sazvar et al. (2013), Seyedhosseini and Ghoreyshi (2014a,b), Shah et al. (2014), Tai (2015), Wang and Huang (2014), Wang et al. (2014), Wu and Zhao (2014), Wu and Chan (2014), Wu et al. (2015, 2014a), Xu et al. (2014), Yan et al. (2013), and Zhou et al. (2012)		
(1b)	Agrawal et al. (2013), Ahmed et al. (2013), Alia et al. (2013), Ameli et al. (2013), Amorim et al. (2013), Annadurai (2013a,b), Annadurai and Uthayakumar (2012), Arianezhad et al. (2013), Atici et al. (2013), Avinadav et al. (2014), Bai et al. (2015), Begum et al. (2012a,b), Bhunia et al. (2015a), Bhunia et al. (2014a,b, 2015b), Bhunia and Shaikh (2015), Chakraborty et al. (2015), Chang et al. (2015), Chen and Teng (2014, 2015), Chen et al. (2014b), Chiao et al. (2012), Chou and Peterson (2015), Chowdhury et al. (2014a), Chowdhury et al. (2014b,c), Chung (2012,2013a,b), Chung et al. (2013), Chung and Cárdenas-Barrón (2013), Chung et al. (2012, 2014), Claassen and Hendrix (2014), Dalfard and Nosratian (2012), Das et al. (2012, 2013, 2014, 2015), Dash et al. (2014), Disney and Warburton (2012), Duan et al. (2012b), Dutta and Kumar (2015), Dye (2012, 2013), Dye and Hsieh (2012), Dye and Hsieh (2013b), Dye and Yang (2015), Geetha and Udayakumar (2015a), Geetha and Udayakumar (2015b), Ghasemi (2015), Ghiami and Williams (2015), Ghiami et al. (2013), Ghoreishi et al. (2013a,b), Ghosh et al. (2015), Gilding et al. (2014), Giri and Bardhan (2012), Goel et al. (2015), Guchhait et al. (2013a,b), Guchhait et al. (2015), He and Wang (2012), Hsieh and Dye (2013), Jaggi and Mittal (2012), Jaggi et al. (2013, 2015), Jain and Aggarwal (2012), Jain et al. (2014), Jana et al. (2013), Jeang (2012), Jiang et al. (2015), Jiangtao et al. (2013), Kawakatsu (2013), Khedlekar et al. (2015), Kumar Sett et al. (2012), Kumar et al. (2012a,b, 2013), Kumar and Singh (2015), Lee and Chung (2012), Lee and Kim (2014), Lee and Dye (2012), Li et al. (2015, 2014), Liao et al. (2012, 2013), Lin et al. (2012), Lin (2013), Lu et al. (2014), Maddah et al. (2014), Mahata (2012, 2015a,b), Mahata et al. (2015), Maihami and Abadi (2012), Maihami et al. (2012), Min et al. (2012), Mirzaei and Seifi (2015), Mishra and Singh (2013), Mishra (2015), Mishra et al. (2013), Muniappan et al. (2015b), Musa and Sani (2012), Nasr et al. (2014), Novotna and Varysova (2015), Ouyang et al. (2014), Pal et al. (2014,2015), Palanivel et al. (2015), Palanivel and Uthayakumar (2013a,b, 2014, 2015a,b), Pareek and Dhaka (2015), Pathak et al. (2013), Pattnaik (2012a), Pervin et al. (2015), Prasad and Mukherjee (2014), Priyan and Uthayakumar (2015), Purohit and Rathore (2012), Qin et al. (2014), Rabbani et al. (2015), Rahdar and Nookabadi (2013), Rajoria et al. (2014), Roy (2014), Sanni and Chukwu (2013), Sarkar (2012, 2013), Sarkar et al. (2013, 2014), Sarkar and Sarkar (2013a,b,c), Sarkar et al. (2012), Sarker and Wu (2015), Sazvar et al. (2012), Shah (2015a,b), Shah and Patel (2012), Shah and Shah (2013), Shah et al. (2013b, 2014), Sharma et al. (2015), Sharma and Rani Chaudhary (2013), Shastri et al. (2013), Sicilia et al. (2013), Sicilia et al. (2014), Singh and Sharma (2013), Singh and Vishnoi (2013), Singh and Vishnoi (2014), Singh et al. (2013), Singh and Saxena (2013), Singh and Singh (2013), Singh and Pattnayak (2014), Soni (2013a,b), Soni and Patel (2013), Srivastava and Gupta (2013), Tai (2013), Taleizadeh (2014a,b), Taleizadeh et al. (2013a, 2015), Taleizadeh and Nematollahi (2014), Taleizadeh and Rasuli-baghban (2015), Tat et al. (2013), Tayal et al. (2014a,b, 2015), Thangam (2012), Tripathi and Misra (2012), Tripathi (2014), Tsao (2014), Tyagi et al. (2014, 2015), Urban (2012), Uthayakumar and Rameswari (2012), Uttam et al. (2013), Valliathal and Uthayakumar (2013a,b), Wang and Lin (2012), Wang et al. (2012, 2014), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a), Wu and Sarker (2013), Wu and Chan (2014), Wu et al. (2014a, 2015), Xiao and Xu (2013), Xue et al. (2014), Yadav et al. (2012, 2013), Yang et al. (2013a,b, 2015), Yang (2012a, b), Yang and Chang (2013), Yang and Tseng (2015), Yu (2013), Yu et al. (2012, 2013a), Zhang et al. (2015), and Zhao (2014)		
(2a)	Abad (2014), Abdel-Malek and Otegbeye (2013), Alcoba et al. (2015), Amorim et al. (2013), Baron et al. (2015), Bloomfield and Kulp (2013), Bottani et al. (2014), Boxma et al. (2015), Brito and de Almeida (2012), Carrizosa et al. (2016), Chao et al. (2015), Chen and Sapra (2013), Chen and Ho (2013), Chen et al. (2015), Chen and Zhou (2014), Chintapalli (2014), Civelek et al. (2015), Coelho and Laporte (2014), Deflem and Van Nieuwenhuyse (2013), Diabat et al. (2014), Ding (2013), Ding and Yuan (2014), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Duan and Liao (2014), Duan and Liao (2013), Duong et al. (2015), Egri and Váncza (2012), Fan et al. (2015), Firoozi et al. (2013), Firoozi et al. (2014), Gaggero and Tonelli (2015), Gumasta et al. (2012), Gunpinar and Centeno (2015), Haijema (2013, 2014), Hanasusanto et al. (2014), Herbon et al. (2012a), Hosseinipour and Sandoh (2013), Huang (2014), Jammernegg and Kischka (2013), Jeong and Leon (2012), Jörnsten et al. (2012), Ketzenberg et al. (2014), Khouja et al. (2013), Kim et al. (2015), Kitaeva et al. (2015), Kouki et al. (2015), Kouki et al. (2013b), Kuthambalayan et al. (2015), Levi et al. (2015), Lowalekar and Ravichandran (2015), Luo et al. (2012), Mahmoodi et al. (2015), Murray et al. (2012), Ng et al. (2012), Nilsen (2013), Olsson (2014), Pal et al. (2013), Pando et al. (2013), Qin and Kar (2013), Qiu et al. (2014), Ramadhan and Simatupang (2012), Raza (2013), Rijpkemaa et al. (2014), Roy et al. (2012), Sachs and Minner (2014), Sainathan (2013), Seyedhosseini and Ghoreyshi (2015a), Sun et al. (2013), Tai (2015), Tsai and Huang (2012), Uthayakumar and Priyan (2013), van Donselaar and Broekmeulen (2012b), Wu et al. (2013), Xu and Lu (2013), Xu et al. (2015), Xu and Ju (2012), Yan and Wang (2013), Hui and Zhai (2014), Yu et al. (2013b), and Zhang et al. (2014)		
(2b)	Al Hamadi et al. (2014), Alizadeh et al. (2014), Amorim et al. (2013), Cai et al. (2013), Chakraborty et al. (2013), Chaudhary et al. (2015), Chauhan and Singh (2015), Chung et al. (2015), Garg (2015), Guchhait et al. (2014), Herbon et al. (2012b), Hu et al. (2015), Huang (2013), Ignaciuk and Bartoszewicz (2012a,b,c,d), Jayaraman et al. (2012), Jiang et al. (2015), Karmakar et al. (2015), Ketzenberg et al. (2014), Kouki et al. (2013a), Kouki and Jouini (2015), Lesniewski and Bartoszewicz (2013, 2014), Li et al. (2013), Lin (2013), Maihami and Karimi (2014), Majumder et al. (2015), Makkar and Jha (2012), Malligarjunan (2014), Mohanty et al. (2015), Molana et al. (2012), Moussawi-Haidar et al. (2014), Pan and Li (2014), Pattnaik (2012b), Rijpkemaa et al. (2014), Sangeetha et al. (2014), Satheesh Kumar et al. (2012), Sazvar et al. (2014), Shabani et al. (2015), Shah et al. (2013a), Shophia Lawrence et al. (2013), Shukla and Jharkharia (2014), Soni and Joshi (2013), Soysal et al. (2015), Suban and Bogataj (2015), Taleizadeh et al. (2013b), Tan and Weng (2013), Vijaya Laxmi and Soujanya (2015), Xu (2014), and Yadavalli et al. (2015)		

Table A2
Literature references for existing demand distribution functions (I-VI).

Demand distribution functions	
(I) Uniform/constant:	53
(II) Stock-level-dependent:	44
(III) Time-varying:	75
(IV) Price-dependent:	73
(V) Age-dependent:	13
(VI) Others dependent	25
(I)	Annadurai and Uthayakumar (2012), Arianezhad et al. (2013), Atan and Rousseau (2015), Bhunia et al. (2014a), Chen and Teng (2014), Chen et al. (2014b), Chung et al. (2012, 2014), Das et al. (2013), Duan et al. (2012a), Ghasemi (2015), Ghiami and Williams (2015), Jaggi and Mittal (2012), Jeang (2012), Karmakar et al. (2015), Kawakatsu (2013), Lee and Chung (2012), Lee and Kim (2014), Lee et al. (2014), Li et al. (2015), Liao et al. (2012), Mahata (2012), Muniappan et al. (2015b), Nasr et al. (2014), Palanivel et al. (2015), Pareek and Dhaka (2015), Pattnaik (2012a), Purohit and Rathore (2012), Rahdar and Nookabadi (2013), Sanni and Chukwu (2013), Sarkar (2013), Sarkar et al. (2014), Sarker and Wu (2015), Sazvar et al. (2012, 2013), Shabani et al. (2015), Shah et al. (2014), Shastri et al. (2013), Singh and Saxena (2013), Singh and Pattnayak (2014), Tai (2013), Taleizadeh (2014a), Taleizadeh and Nematollahi (2014), Thangam (2012), Tripathi and Misra (2012), Tripathi (2014), Wang et al. (2012), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a), Yan et al. (2013), Yang (2012b), and Yang and Chang (2013)
(II)	Bai et al. (2015), Bhunia et al. (2014b), Bhunia et al. (2015b), Chakraborty et al. (2015), Chowdhury et al. (2014a), Chowdhury et al. (2014c), Chung (2013a), Chung and Cárdenas-Barrón (2013), Das et al. (2012, 2014), Duan et al. (2012b), Ghiami et al. (2013), Ghosh et al. (2015), Giri and Bardhan (2012), Goel et al. (2015), Guchhait et al. (2013a,b, 2014), Jain et al. (2014), Jana et al. (2013), Jiangtao et al. (2013), Kumar and Singh (2015), Kumar et al. (2012b, 2013), Lee and Dye (2012), Lin et al. (2012), Lu et al. (2014), Min et al. (2012), Prasad and Mukherjee (2014), Qin et al. (2014), Sarkar and Sarkar (2013a,b), Shah and Patel (2012), Shah and Shah (2013), Soni (2013a,b), Tyagi et al. (2015), Urban (2012), Uthayakumar and Rameswari (2012), Wu et al. (2015), Yadav et al. (2012), Yang et al. (2013b), Zhang et al. (2015), and Zhou et al. (2012)
(III)	Agrawal et al. (2013), Ahmed et al. (2013), Amirthakodi et al. (2015), Avinadav et al. (2013), Bai et al. (2015), Begum et al. (2012b), Bhunia et al. (2015a,b), Chao et al. (2015), Chauhan and Singh (2015), Chen et al. (2014c), Chen and Dye (2013), Chowdhury et al. (2014b), Chung (2012), Dutta and Kumar (2015), Dye (2012), Dye and Yang (2015), Geetha and Udayakumar (2015b), Ghoreishi et al. (2013a,b), Gilding et al. (2014), Guchhait et al. (2013a), Gumasta et al. (2012), Herbon (2013, 2015a,b), Hsieh and Dye (2013), Ignaciuk and Bartoszewicz (2012a,b,c) Jaggi et al. (2013), Khedlekar et al. (2015), Kumar Sett et al. (2012), Kumar et al. (2012a, 2013), Lesniewski and Bartoszewicz (2013, 2014), Lin (2013), Maihami and Abadi (2012), Maihami et al. (2012), Mishra and Singh (2013), Mishra (2015), Mishra et al. (2013), Novotna and Varysova (2015), Olsson (2014), Pal et al. (2014, 2015), Pan and Li (2014), Pathak et al. (2013), Pervin et al. (2015), Prasad and Mukherjee (2014), Rabbani et al. (2015), Rajoria et al. (2014), Sanni and Chukwu (2013), Sarkar (2012), Sarkar et al. (2012, 2013), Sarkar and Sarkar (2013c), Shah (2015a), Sharma and Rani Chaudhary (2013), Sicilia et al. (2013), Singh and Sharma (2013), Singh and Vishnoi (2014), Soni and Patel (2013), Srivastava and Gupta (2013), Tan and Weng (2013), Tayal et al. (2014b), Valliathal and Uthayakumar (2013a, b), Wang and Huang (2014), Wang and Lin (2012), Xu et al. (2014), Yang et al. (2015), Yang (2012a), and Zhao (2014)
(IV)	Abad (2014), Ameli et al. (2013), Annadurai (2013b), Avinadav et al. (2013, 2014), Bai et al. (2015), Baron et al. (2015), Begum et al. (2012a), Bhunia and Shaikh (2015), Bhunia et al. (2015b), Cai et al. (2013), Chakraborty et al. (2013), Chang et al. (2015), Chen et al. (2014c), Chew et al. (2014), Chintapalli (2014), Chowdhury et al. (2014a), Chung et al. (2013), Dalfard and Nosratian (2012), Das et al. (2014), Dye (2012), Dye and Hsieh (2013b), Dye and Yang (2015), Geetha and Udayakumar (2015a), Ghoreishi et al. (2013a,b), Giri and Bardhan (2012), Guchhait et al. (2013b, 2014), He and Huang (2013), Herbon (2013, 2015a,b), Herbon et al. (2014), Jammernegg and Kischka (2013), Kitaeva et al. (2015), Li et al. (2012, 2014), Liu et al. (2014), Mahata (2015a), Mahata et al. (2015), Maihami and Abadi (2012), Maihami and Karimi (2014), Maihami et al. (2012), Palanivel and Uthayakumar (2013a,b, 2014), Qin et al. (2014), Rabbani et al. (2015), Roy (2014), Sachs and Minner (2014), Shah and Patel (2012), Shah and Shah (2013), Shah et al. (2013b), Sharma et al. (2015), Singh and Vishnoi (2013), Singh et al. (2013), Soni (2013b), Soni and Joshi (2013), Soni and Patel (2013), Srivastava and Gupta (2013), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Tayal et al. (2014b), Wang and Huang (2014), Wang and Lin (2012), Xiao and Xu (2013), Xu and Lu (2013), Yang and Tseng (2015), Yang et al. (2013a), Yu (2013), and Yu et al. (2013a,b)
(V)	Amorim et al. (2013), Avinadav et al. (2014), Cai et al. (2013), Gaggero and Tonelli (2015), Herbon (2013), Herbon et al. (2012b, 2014), Li et al. (2013), Li et al. (2012), Mirzaei and Seifi (2015), Musa and Sani (2012), Piramuthu and Zhou (2013), and Wu et al. (2015)
(VI)	Bai et al. (2015), Bhunia et al. (2015b), Chowdhury et al. (2014c), Chung (2013a), Chung et al. (2013), Geetha and Udayakumar (2015a), Guchhait et al. (2015), Jain and Aggarwal (2012), Liu et al. (2014), Mahata (2015b), Murray et al. (2012), Palanivel and Uthayakumar (2013a,b, 2014, 2015a), Qin et al. (2014), Rabbani et al. (2015), Shah (2015b), Shah et al. (2013b), Singh et al. (2013), Wang et al. (2014), Wu et al. (2015), Xiao and Xu (2013), Xue et al. (2014), and Yang et al. (2015)

Appendix B. References to key topics review of inventory models for perishable items

Table B1
Literature references to all (joint) key topics.

Key topic	Literature references to all (join) key topics
01–01	Abad (2014), Avinadav et al. (2013, 2014), Baron et al. (2015), Bhunia et al. (2014b), Chakraborty et al. (2013), Chang et al. (2015), Chen and Ho (2013), Chen and Sapra (2013), Chen et al. (2014c), Chew et al. (2014), Chintapalli (2014), Chowdhury et al. (2014a), Chung et al. (2013, 2015), Dalfard and Nosratian (2012), Dye (2012), Dye and Hsieh (2013b), Dye and Yang (2015), Ghoreishi et al. (2013a,b), Herbon et al. (2012a,b, 2014), Herbon (2013, 2015a,b), Hu et al. (2015), Jammernegg and Kischka (2013), Jana et al. (2013), Kawakatsu (2013), Kazaz and Webster (2015), Khouja et al. (2013), Kitaeva et al. (2015), Kuthambalayan et al. (2015), Li et al. (2012, 2013, 2014), Liu et al. (2014), Lu et al. (2014), Mahata (2015a), Mahata et al. (2015), Maihami et al. (2012), Maihami and Abadi (2012), Maihami and Karimi (2014), Makkar and Jha (2012), Mohanty et al. (2015), Muniappan et al. (2015a), Murray et al. (2012), Ouyang et al. (2014), Qin et al. (2014), Rabbani et al. (2015), Raza (2013), Sainathan (2013), Sarkar et al. (2013), Shah and Shah (2013), Soni and Joshi (2013), Soni and Patel (2013), Taleizadeh et al. (2013a,b, 2015), Taleizadeh and Rasuli-baghban (2015), Wang and Lin (2012), Wang and Huang (2014), Xiao and Xu (2013), Xu and Lu (2013), Xue et al. (2014), Yan and Wang (2013), Yang (2012a), Yang et al. (2013a), and Zhang et al. (2015)
01–02	Abad (2014), Avinadav et al. (2013, 2014), Bhunia et al. (2014b), Chen and Sapra (2013), Chen et al. (2014c), Dalfard and Nosratian (2012), Dye (2012), Ghoreishi et al. (2013b), Jammernegg and Kischka (2013), Jana et al. (2013), Li et al. (2012), Maihami et al. (2012), Maihami and Abadi (2012), Maihami and Karimi (2014), Mohanty et al. (2015), Muniappan et al. (2015a), Raza (2013), Sainathan (2013), Taleizadeh et al. (2013a), Taleizadeh and Rasuli-baghban (2015), Xiao and Xu (2013), Yan and Wang (2013), and Yang (2012a)
01–03	Chakraborty et al. (2013), Makkar and Jha (2012), and Murray et al. (2012)
01–04	Ghoreishi et al. (2013a,b) and Jana et al. (2013)
01–05	Chang et al. (2015), Dye (2012), Mahata (2015a), Mahata et al. (2015), Maihami and Abadi (2012), Soni and Joshi (2013), and Taleizadeh et al. (2013b)
01–06	Dye and Yang (2015), Maihami and Karimi (2014), Murray et al. (2012), and Shah and Shah (2013)
01–07	Chen et al. (2014c)
01–08	Baron et al. (2015), Dye and Hsieh (2013b), Ghoreishi et al. (2013a,b), Herbon et al. (2012b, 2014), Herbon (2013, 2015a), Hu et al. (2015), Kazaz and Webster (2015), and Kuthambalayan et al. (2015)
01–09	Chen and Sapra (2013), Chew et al. (2014), and Sainathan (2013)
01–10	Herbon et al. (2012a, 2014)
01–11	Makkar and Jha (2012) and Taleizadeh and Rasuli-baghban (2015)
01–12	Muniappan et al. (2015a) and Yang et al. (2013a)
01–14	Chung et al. (2015), Makkar and Jha (2012), Wang and Lin (2012), Xiao and Xu (2013), and Yang et al. (2013a)
01–15	Chung et al. (2013), Kawakatsu (2013), Mahata et al. (2015), Muniappan et al. (2015a), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Xiao and Xu (2013), and Yang et al. (2013a)
01–16	Chung et al. (2013), Dalfard and Nosratian (2012), Kazaz and Webster (2015), Kuthambalayan et al. (2015), Li et al. (2014), Mahata et al. (2015), Muniappan et al. (2015a), Sarkar et al. (2013), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Wang and Huang (2014), Xiao and Xu (2013), Xu and Lu (2013), and Yang et al. (2013a)
01–18	Abad (2014), Baron et al. (2015), Chen and Ho (2013), Jammernegg and Kischka (2013), Kazaz and Webster (2015), Khouja et al. (2013), Kitaeva et al. (2015), Kuthambalayan et al. (2015), Murray et al. (2012), Raza (2013), and Xu and Lu (2013)
01–19	Kazaz and Webster (2015)
01–20	Murray et al. (2012)
02–02	Abad (2014), Agrawal et al. (2013), Ahmed et al. (2013), Alcoba et al. (2015), Alia et al. (2013), Alizadeh et al. (2014), Annadurai and Uthayakumar (2012), Annadurai (2013a,b), Atan and Rousseau (2015), Atici et al. (2013), Avinadav et al. (2013, 2014), Begum et al. (2012b), Bhunia et al. (2015a,b, 2014a,b),Bhunia and Shaikh (2015), Bottani et al. (2014), Brito and de Almeida (2012), Chao et al. (2015), Chaudhary et al. (2015), Chen and Sapra (2013), Chen et al. (2014c, 2015), Chen and Zhou (2014), Chou and Peterson (2015), Chowdhury et al. (2014b,c), Chung (2012), Civelek et al. (2015), Dalfard and Nosratian (2012), Das et al. (2014), Deflem and Van Nieuwenhuyse (2013), van Donselaar and Broekmeulen (2012b), Dobhan and Oberlaender (2013), Duan et al. (2012b), Duan and Liao (2013), Duong et al. (2015), Dutta and Kumar (2015), Dye (2012, 2013), Dye and Hsieh (2012), Egri and Váncza (2012), Firoozi et al. (2014), Garg (2015), Geetha and Udayakumar (2015a), Ghasemi (2015), Ghiami et al. (2013), Ghoreishi et al. (2013b), Gilding et al. (2014), Goel et al. (2015), Guchhait et al. (2013a, 2014), Gumasta et al. (2012), Gunpinar and Centeno (2015), Haijema (2013), Huang (2013), Ignaciuk and Bartoszewicz (2012a,b,c,d), Jaggi and Mittal (2012), Jain et al. (2014), Jammernegg and Kischka (2013), Jana et al. (2013), Jayaraman et al. (2012), Khedlekar et al. (2015), Kouki et al. (2013a, 2015), Kumar et al. (2012a, 2013), Kumar and Singh (2015), Lee and Dye (2012), Li et al. (2012), Lin (2013), Lin et al. (2013), Luo et al. (2012), Maddah et al. (2014), Mahmoodi et al. (2015), Maihami et al. (2012), Maihami and Abadi (2012), Maihami and Karimi (2014), Malligarjunan (2014), Mirzaei and Seifi (2015), Mishra et al. (2013), Mishra (2015), Mohanty et al. (2015), Molana et al. (2012), Muniappan et al. (2015a,b), Ng et al. (2012), Olsson (2014), Pal et al. (2013, 2015), Palanivel and Uthayakumar (2013a,b, 2014, 2015b), Pando et al. (2013), Pathak et al. (2013), Prasad and Mukherjee (2014), Ramadhan and Simatupang (2012), Raza (2013), Rijpkemaa et al. (2014), Roy et al. (2012), Mishra and Singh (2013), Sachs and Minner (2014), Sainathan (2013), Sanni and Chukwu (2013), Sarkar et al. (2012), Sarkar and Sarkar (2013a), Sarker and Wu (2015), Sazvar et al. (2012, 2013, 2014), Sharma and Rani Chaudhary (2013), Sharma et al. (2015), Shastri et al. (2013), Shukla and Jharkharia (2014), Sicilia et al. (2014), Singh and Vishnoi (2013), Singh and Sharma (2013), Singh and Saxena (2013), Singh and Pattnayak (2014), Singh and Vishnoi (2014), Sun et al. (2013), Tai (2013), Taleizadeh et al. (2013a), Taleizadeh (2014a,b), Taleizadeh and Nematollahi (2014), Taleizadeh and Rasuli-baghban (2015), Tan and Weng (2013), Tripathi (2014), Tyagi et al. (2014, 2015), Uthayakumar and Rameswari (2012), Uthayakumar and Priyan (2013), Uttam et al. (2013), Valliathal and Uthayakumar (2013a,b), Wee and Widyadana (2012, 2013), Wu and Sarker (2013), Xiao and Xu (2013), Xu et al. (2015), Yan and Wang (2013), Yan et al. (2013), Yang (2012a,b), Yang and Chang (2013), Yu (2013), Yu et al. (2013b), Hui and Zhai (2014), and Zhao (2014)
02–03	Chen et al. (2015), Das et al. (2014), Deflem and Van Nieuwenhuyse (2013), Gumasta et al. (2012), Jain et al. (2014), Uthayakumar and Priyan (2013), and Yan et al. (2013)
02–04	Alia et al. (2013), Bhunia et al. (2015a), Ghoreishi et al. (2013b), Gilding et al. (2014), Guchhait et al. (2013a), Jain et al. (2014), Jana et al. (2013), Kumar et al. (2012a, 2013), Muniappan et al. (2015b), Pal et al. (2015), Palanivel and Uthayakumar (2013a,b, 2014, 2015b), Shastri et al. (2013), Taleizadeh and Nematollahi (2014), Uthayakumar and Rameswari (2012), Yang (2012b), and Yang and Chang (2013)
02–05	Annadurai and Uthayakumar (2012), Annadurai (2013b), Bhunia et al. (2014a), Bhunia and Shaikh (2015), Das et al. (2014), Dye (2012), Guchhait et al. (2014), Jaggi and Mittal (2012), Maihami and Abadi (2012), Muniappan et al. (2015b), Palanivel and Uthayakumar (2015b), Singh and Sharma (2013), Singh and Pattnayak (2014), Singh and Vishnoi (2014), Taleizadeh (2014a,b), Taleizadeh and Nematollahi (2014), Uthayakumar and Priyan (2013), Yang and Chang (2013), and Yu (2013)
02–06	Chaudhary et al. (2015), Dye and Hsieh (2012), Dye (2013), Lee and Dye (2012), Maihami and Karimi (2014), and Singh and Sharma (2013)
02–07	Chao et al. (2015), Chen et al. (2014c), Civelek et al. (2015), van Donselaar and Broekmeulen (2012b), Duong et al. (2015), Gumasta et al. (2012), Gunpinar and Centeno (2015), Haijema (2013), Olsson (2014), Ramadhan and Simatupang (2012), Rijpkemaa et al. (2014), and Singh and Saxena (2013)
02–08	Chen and Zhou (2014), Ghoreishi et al. (2013b), Gunpinar and Centeno (2015), Mahmoodi et al. (2015), Malligarjunan (2014), Pal et al. (2013), Rijpkemaa et al. (2014), Mishra and Singh (2013), Sun et al. (2013), and Xu et al. (2015)

Table B1 (*continued*)

Key topic	Literature references to all (join) key topics
02–09	Chen and Sapra (2013), Chen et al. (2015), Civelek et al. (2015), Deflem and Van Nieuwenhuyse (2013), Duong et al. (2015), Haijema (2013), Ng et al. (2012), Sainathan (2013), Shukla and Jharkharia (2014), and Wee and Widyadana (2013)
02–11	Dobhan and Oberlaender (2013), Firoozi et al. (2014), Gumasta et al. (2012), Mirzaei and Seifi (2015), Rijpkemaa et al. (2014), Sazvar et al. (2014), Taleizadeh and Rasuli-baghban (2015), Uthayakumar and Priyan (2013), and Wu and Sarker (2013)
02–12	Guchhait et al. (2013a), Muniappan et al. (2015a), Sarker and Wu (2015), Singh and Saxena (2013), Tai (2013), and Wee and Widyadana (2012, 2013)
02–13	Agrawal et al. (2013), Bhunia et al. (2014a, 2015a,b), Bhunia and Shaikh (2015), Das et al. (2014), Ghiami et al. (2013), Kumar et al. (2012a, 2013), Kumar and Singh (2015), Palanivel and Uthayakumar (2015b), Singh and Vishnoi (2013), Singh and Pattnayak (2014), Singh and Vishnoi (2014), Valliathal and Uthayakumar (2013a), Yang (2012b), and Yang and Chang (2013)
02–14	Dobhan and Oberlaender (2013), Duan and Liao (2013), Egri and Váncza (2012), Ghiami et al. (2013), Gunpinar and Centeno (2015), Ignaciuk and Bartoszewicz (2012d), Rijpkemaa et al. (2014), and Xiao and Xu (2013)
02–15	Annadurai and Uthayakumar (2012), Bottani et al. (2014), Chaudhary et al. (2015), Dobhan and Oberlaender (2013), Duan and Liao (2013), Duong et al. (2015), Firoozi et al. (2014), Goel et al. (2015), Gunpinar and Centeno (2015), Luo et al. (2012), Muniappan et al. (2015a), Roy et al. (2012), Sarker and Wu (2015), Sazvar et al. (2012, 2014), Shastri et al. (2013), Singh and Vishnoi (2013), Singh and Saxena (2013), Taleizadeh and Rasuli-baghban (2015), Uthayakumar and Priyan (2013), Wu and Sarker (2013), Xiao and Xu (2013), and Yu (2013)
02–16	Chao et al. (2015), Chaudhary et al. (2015), Dalfard and Nosratian (2012), Dobhan and Oberlaender (2013), Duan and Liao (2013), Egri and Váncza (2012), Garg (2015), Ghasemi (2015), Goel et al. (2015), Guchhait et al. (2013a), Luo et al. (2012), Maddah et al. (2014), Muniappan et al. (2015a), Ng et al. (2012), Pal et al. (2015), Palanivel and Uthayakumar (2013a), Palanivel and Uthayakumar (2014), Pathak et al. (2013), Roy et al. (2012), Sarker and Wu (2015), Sazvar et al. (2012), Sharma et al. (2015), Shastri et al. (2013), Singh and Vishnoi (2013), Singh and Saxena (2013), Tai (2013), Taleizadeh and Rasuli-baghban (2015), Tripathi (2014), Uthayakumar and Priyan (2013), Valliathal and Uthayakumar (2013b), Wee and Widyadana (2012, 2013), Wu and Sarker (2013), Xiao and Xu (2013), and Yan et al. (2013)
02–17	Civelek et al. (2015), Gunpinar and Centeno (2015), and Haijema (2013)
02–18	Abad (2014), Brito and de Almeida (2012), Chen et al. (2015), Deflem and Van Nieuwenhuyse (2013), Dobhan and Oberlaender (2013), Egri and Váncza (2012), Huang (2013), Jammernegg and Kischka (2013), Luo et al. (2012), Ng et al. (2012), Pal et al. (2013), Pando et al. (2013), Raza (2013), Roy et al. (2012), Sachs and Minner (2014), Sun et al. (2013), Xu et al. (2015), Yu et al. (2013b), and Hui and Zhai (2014)
02–19	Lin et al. (2013)
02–20	Atan and Rousseau (2015), Jaggi and Mittal (2012), Jayaraman et al. (2012), Maddah et al. (2014), Molana et al. (2012), Ng et al. (2012), and Sazvar et al. (2013)
03–03	Abdel-Malek and Otegbeye (2013), Chakraborty et al. (2013), Chakraborty et al. (2015), Chen et al. (2015), Das et al. (2014), Deflem and Van Nieuwenhuyse (2013), Ding (2013), Ding and Yuan (2014), Ghosh et al. (2015), Gumasta et al. (2012), Hanasusanto et al. (2014), Jain et al. (2014), Jiangtao et al. (2013), Makkar and Jha (2012), Murray et al. (2012), Purohit and Rathore (2012), Uthayakumar and Priyan (2013), Yadav et al. (2012), Yadavalli et al. (2015), and Yan et al. (2013)
03–04	Jain et al. (2014) and Yadav et al. (2012)
03–05	Chakraborty et al. (2015), Das et al. (2014), Jiangtao et al. (2013), and Uthayakumar and Priyan (2013)
03–06	Murray et al. (2012)
03–07	Gumasta et al. (2012)
03–09	Chen et al. (2015), Deflem and Van Nieuwenhuyse (2013), and Yadavalli et al. (2015)
03–11	Chakraborty et al. (2015), Gumasta et al. (2012), Hanasusanto et al. (2014), Makkar and Jha (2012), and Uthayakumar and Priyan (2013)
03–13	Das et al. (2014) and Yadav et al. (2012)
03–14	Chakraborty et al. (2015) and Makkar and Jha (2012)
03–15	Chakraborty et al. (2015) and Uthayakumar and Priyan (2013)
03–16	Chakraborty et al. (2015), Uthayakumar and Priyan (2013), and Yan et al. (2013)
03–18	Abdel-Malek and Otegbeye (2013), Chen et al. (2015), Deflem and Van Nieuwenhuyse (2013), Ding (2013), Ding and Yuan (2014), Hanasusanto et al. (2014), and Murray et al. (2012)
03–20	Murray et al. (2012)
04–04	Alia et al. (2013), Ameli et al. (2013), Bhunia et al. (2015a), Chauhan and Singh (2015), Das et al. (2012), Ghoreishi et al. (2013a,b), Gilding et al. (2014), Guchhait et al. (2013a), Jaggi et al. (2013), Jain and Aggarwal (2012), Jain et al. (2014), Jana et al. (2013), Kumar et al. (2012a,b, 2013), Muniappan et al. (2015b), Pal et al. (2014, 2015), Palanivel and Uthayakumar (2013a,b, 2014, 2015b), Pareek and Dhaka (2015), Rajoria et al. (2014), Sarkar and Sarkar (2013c), Shastri et al. (2013), Taleizadeh and Nematollahi (2014), Tayal et al. (2014b), Uthayakumar and Rameswari (2012), Yadav et al. (2012, 2013), Yang (2012b), Yang et al. (2013b), and Yang and Chang (2013)
04–05	Jain and Aggarwal (2012), Muniappan et al. (2015b), Palanivel and Uthayakumar (2015b), Pareek and Dhaka (2015), Taleizadeh and Nematollahi (2014), Yadav et al. (2013), Yang et al. (2013b), and Yang and Chang (2013)
04–06	Tayal et al. (2014b)
04–08	Ghoreishi et al. (2013a,b)
04–12	Guchhait et al. (2013a), Jaggi et al. (2013), and Sarkar and Sarkar (2013c)
04–13	Bhunia et al. (2015a), Das et al. (2012), Kumar et al. (2012a,b, 2013), Palanivel and Uthayakumar (2015b), Yadav et al. (2012), Yang (2012b), and Yang and Chang (2013)
04–14	Kumar et al. (2012b) and Tayal et al. (2014b)
04–15	Shastri et al. (2013)
04–16	Guchhait et al. (2013a), Pal et al. (2014, 2015), Palanivel and Uthayakumar (2013a, 2014), Sarkar and Sarkar (2013c), and Shastri et al. (2013)
05–05	Annadurai and Uthayakumar (2012), Annadurai (2013b), Bhunia et al. (2014a), Bhunia and Shaikh (2015), Chakraborty et al. (2015), Chang et al. (2015), Chen et al. (2014a), Chen et al. (2014b), Chen and Teng (2014, 2015), Chung et al. (2012, 2014), Chung (2013b), Chung and Cárdenas-Barrón (2013), Das et al. (2013, 2014, 2015), Duan et al. (2012a), Dye (2012), Geetha and Udayakumar (2015b), Guchhait et al. (2013b, 2014, 2015), Jaggi and Mittal (2012), Jain and Aggarwal (2012), Jiangtao et al. (2013), Liao et al. (2012, 2013), Mahata (2012, 2015a,b), Mahata et al. (2015), Maihami and Abadi (2012), Majumder et al. (2015), Min et al. (2012), Muniappan et al. (2015b), Musa and Sani (2012), Novotna and Varysova (2015), Palanivel et al. (2015), Palanivel and Uthayakumar (2015b), Pareek and Dhaka (2015), Pattnaik (2012a), Pervin et al. (2015), Sarkar (2012), Sarkar et al. (2014), Shabani et al. (2015), Shah and Patel (2012), Shah et al. (2013a,b, 2014), Shah (2015a,b), Singh and Sharma (2013), Singh et al. (2013), Singh and Pattnayak (2014), Singh and Vishnoi (2014), Soni and Joshi (2013), Soni (2013a,b), Taleizadeh et al. (2013b), Taleizadeh (2014a,b), Taleizadeh and Nematollahi (2014), Thangam (2012), Ting (2015), Tripathi and Misra (2012), Tsao (2014), Urban (2012), Uthayakumar and Priyan (2013), Wang et al. (2014), Wu et al. (2014a,b), Wu and Zhao (2014), Wu and Chan (2014), Xu (2014), Yadav et al. (2013), Yang et al. (2013b, 2015), Yang and Chang (2013), Yu (2013), and Zhou et al. (2012)
05–06	Singh and Sharma (2013) and Yang et al. (2015)
05–08	Tsao (2014) and Wu and Chan (2014)
05–09	Duan et al. (2012a)
05–11	Chakraborty et al. (2015), Shah (2015a), Tsao (2014), and Uthayakumar and Priyan (2013)
05–13	Bhunia et al. (2014a), Bhunia and Shaikh (2015), Chung (2013b), Das et al. (2014), Guchhait et al. (2013b), Liao et al. (2012, 2013), Palanivel and Uthayakumar (2015b), Shabani et al. (2015), Singh and Pattnayak (2014), Singh and Vishnoi (2014), and Yang and Chang (2013)
05–14	Chakraborty et al. (2015), Chen and Teng (2015), Duan et al. (2012a), Wu and Zhao (2014), and Zhou et al. (2012)

Table B1 (*continued*)

Key topic	Literature references to all (join) key topics
05–15	Annadurai and Uthayakumar (2012), Chakraborty et al. (2015), Chen et al. (2014b), Chen and Teng (2014), Chung et al. (2012, 2014), Chung and Cárdenas-Barrón (2013), Das et al. (2013, 2015), Duan et al. (2012a), Mahata (2012, 2015b), Mahata et al. (2015), Shah and Patel (2012), Shah et al. (2013a), Shah (2015a), Thangam (2012), Uthayakumar and Priyan (2013), Wang et al. (2014), Wu and Zhao (2014), Wu et al. (2014a), and Yu (2013)
05–16	Chakraborty et al. (2015), Chen et al. (2014b), Chung (2013b), Chung et al. (2014), Das et al. (2013, 2015), Duan et al. (2012a), Mahata (2012), Mahata et al. (2015), Majumder et al. (2015), Min et al. (2012), Shah et al. (2013a), Shah (2015a), and Uthayakumar and Priyan (2013)
05–19	Chen et al. (2014a), Ting (2015), and Wu et al. (2014b)
05–20	Jaggi and Mittal (2012)
06–06	Chaudhary et al. (2015), Chen and Dye (2013), Dye and Hsieh (2012), Dye (2013), Dye and Yang (2015), He and Huang (2013), Hsieh and Dye (2013), Lee and Dye (2012), Maihami and Karimi (2014), Murray et al. (2012), Palanivel and Uthayakumar (2015a), Pan and Li (2014), Pattnaik (2012b), Shah and Shah (2013), Singh and Sharma (2013), Tayal et al. (2014b), and Yang et al. (2015)
06–07	Pattnaik (2012b)
06–08	He and Huang (2013)
06–14	Tayal et al. (2014b)
06–15	Chaudhary et al. (2015)
06–16	Chaudhary et al. (2015), Hsieh and Dye (2013), Palanivel and Uthayakumar (2015a), and Pan and Li (2014)
06–18	Murray et al. (2012)
06–20	Murray et al. (2012)
07–07	Boxma et al. (2015), Chao et al. (2015), Chen et al. (2014c), Civelek et al. (2015), van Donselaar and Broekmeulen (2012b), Duan and Liao (2014), Duong et al. (2015), Fan et al. (2015), Gaggero and Tonelli (2015), Gumasta et al. (2012), Gunpinar and Centeno (2015), Haijema (2013, 2014), Kouki et al. (2013b), Olsson (2014), Pattnaik (2012b), Ramadhan and Simatupang (2012), Rijpkemaa et al. (2014), Singh and Saxena (2013), Soysal et al. (2015), and Suban and Bogataj (2015)
07–08	Boxma et al. (2015), Gunpinar and Centeno (2015), and Rijpkemaa et al. (2014)
07–09	Civelek et al. (2015), Duan and Liao (2014), Duong et al. (2015), Haijema (2013, 2014), and Kouki et al. (2013b)
07–10	Fan et al. (2015) and Kouki et al. (2013b)
07–11	Gaggero and Tonelli (2015), Gumasta et al. (2012), Rijpkemaa et al. (2014), and Soysal et al. (2015)
07–12	Singh and Saxena (2013)
07–14	Fan et al. (2015), Gunpinar and Centeno (2015), and Rijpkemaa et al. (2014)
07–15	Duan and Liao (2014), Duong et al. (2015), Fan et al. (2015), Gunpinar and Centeno (2015), and Singh and Saxena (2013)
07–16	Chao et al. (2015) and Singh and Saxena (2013)
07– 17	Civelek et al. (2015), Duan and Liao (2014), Gunpinar and Centeno (2015), Haijema (2013), Haijema (2014)
07–20	Soysal et al. (2015)
08–08	Al Hamadi et al. (2014), Amirthakodi et al. (2015), Amorim et al. (2013), Baron et al. (2015), Boxma et al. (2015), Chen and Zhou (2014), Dye and Hsieh (2013b), Ghoreishi et al. (2013a,b), Graczová and Jacko (2014), Gunpinar and Centeno (2015), He and Huang (2013), Herbon et al. (2012b, 2014), Herbon (2013, 2015a), Hosseinipour and Sandoh (2013), Hu et al. (2015), Jaggi et al. (2015), Kazaz and Webster (2015), Krishnamoorthy et al. (2015), Kuthambalayan et al. (2015), Mahmoodi et al. (2015), Malligarjunan (2014), Moussawi-Haidar et al. (2014), Vijaya Laxmi and Soujanya (2015), Pal et al. (2013), Qiu et al. (2014), Rijpkemaa et al. (2014), Mishra and Singh (2013), Sangeetha et al. (2014), Shukla and Khedlekar (2015), Sun et al. (2013), Tai (2015), Tsao (2014), Wu et al. (2013), Wu and Chan (2014), Xu et al. (2014, 2015), and Yang and Tseng (2015)
08–09	
08–10	Herbon et al. (2014)
08–11	Rijpkemaa et al. (2014) and Tsao (2014)
08–12	Shukla and Khedlekar (2015)
08–13	Jaggi et al. (2015)
08–14	Gunpinar and Centeno (2015) and Rijpkemaa et al. (2014)
08–15	Gunpinar and Centeno (2015)
08–16	Amorim et al. (2013), Kazaz and Webster (2015), Kuthambalayan et al. (2015), Sangeetha et al. (2014), and Shukla and Khedlekar (2015)
08–17	Gunpinar and Centeno (2015)
08–18	Baron et al. (2015), Hosseinipour and Sandoh (2013), Kazaz and Webster (2015), Kuthambalayan et al. (2015), Pal et al. (2013), Qiu et al. (2014), Sun et al. (2013), Wu et al. (2013), and Xu et al. (2015)
08–19	Kazaz and Webster (2015)
08–20	Al Hamadi et al. (2014), Graczová and Jacko (2014), Hosseinipour and Sandoh (2013), Vijaya Laxmi and Soujanya (2015), and Xu et al. (2014)
09–09	Chen and Sapra (2013), Chen et al. (2015), Chew et al. (2014), Civelek et al. (2015), Coelho and Laporte (2014), Deflem and Van Nieuwenhuyse (2013), Duan et al. (2012a), Duan and Liao (2014), Duong et al. (2015), Haijema (2013), Haijema (2014), Kouki et al. (2013b), Lee et al. (2014), Ng et al. (2012), Önal et al. (2015), Sainathan (2013), Shukla and Jharkharia (2014), Wee and Widyadana (2013), and Yadavalli et al. (2015)
09–10	Kouki et al. (2013b)
09–11	Coelho and Laporte (2014)
09–12	Wee and Widyadana (2013)
09–14	Duan et al. (2012a)
09–15	Coelho and Laporte (2014), Duan et al. (2012a), Duan and Liao (2014), and Duong et al. (2015)
09–16	Duan et al. (2012a), Lee et al. (2014), Ng et al. (2012), and Wee and Widyadana (2013)
09–17	Civelek et al. (2015), Duan and Liao (2014), and Haijema (2013, 2014)
09–18	Chen et al. (2015), Deflem and Van Nieuwenhuyse (2013), and Ng et al. (2012)
09–20	Ng et al. (2012) and Önal et al. (2015)
10–10	Fan et al. (2014, 2015), Herbon et al. (2012a, 2014), Ketzenberg et al. (2014), Kouki et al. (2013b), Lim et al. (2013), and Piramuthu and Zhou (2013)
10–14	Fan et al. (2015)
10–15	Fan et al. (2015)
10–18	Fan et al. (2014)
10–19	Lim et al. (2013)
10–20	Ketzenberg et al. (2014)
11–11	Belo-Filho et al. (2015), Cai et al. (2013), Chakraborty et al. (2015), Coelho and Laporte (2014), Diabat et al. (2014), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Firoozi et al. (2013, 2014), Gaggero and Tonelli (2015), Giri and Sharma (2013), Gumasta et al. (2012), Hanasusanto et al. (2014), Jia et al. (2014), Lee and Kim (2014), Leśniewski and Bartoszewicz (2013, 2014), Makkar and Jha (2012), Mirzaei and Seifi (2015), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Rijpkemaa et al. (2014), Sazvar et al. (2014), Seyedhosseini and Ghoreyshi (2014a,b 2015a,b), Shah (2015a), Soysal et al. (2015), Taleizadeh and Rasuli-baghban (2015), Tsao (2014), Uthayakumar and Priyan (2013), Wang et al. (2012), and Wu and Sarker (2013)
11–14	Cai et al. (2013), Chakraborty et al. (2015), Dobhan and Oberlaender (2013), Makkar and Jha (2012), and Rijpkemaa et al. (2014)

Table B1 (*continued*)

Key topic	Literature references to all (join) key topics
11–15	Cai et al. (2013), Chakraborty et al. (2015), Coelho and Laporte (2014), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Firoozi et al. (2013, 2014), Giri and Sharma (2013), Jia et al. (2014), Lee and Kim (2014), Lesniewski and Bartoszewicz (2014, 2015), Rahdar and Nookabadi (2013), Sazvar et al. (2014), Seyedhosseini and Ghoreyshi (2014a,b, 2015a,b), Shah (2015a), Taleizadeh and Rasuli-baghban (2015), Uthayakumar and Priyan (2013), Wang et al. (2012), and Wu and Sarker (2013)
11–16	Belo-Filho et al. (2015), Chakraborty et al. (2015), Dobhan and Oberlaender (2013), Giri and Sharma (2013), Jia et al. (2014), Lee and Kim (2014), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Seyedhosseini and Ghoreyshi (2014a,b, 2015a,b), Shah (2015a), Taleizadeh and Rasuli-baghban (2015), Uthayakumar and Priyan (2013), Wang et al. (2012), and Wu and Sarker (2013)
11– 18	Dobhan and Oberlaender (2013), Drezner and Scott (2013), and Hanasusanto et al. (2014)
11–20	Soysal et al. (2015)
12–12	Chung (2013a), Guchhait et al. (2013a), He and Wang (2012), Jaggi et al. (2013), Jeang (2012), Jiang et al. (2015), Li et al. (2015), Muniappan et al. (2015a), Sarkar and Sarkar (2013c), Sarker and Wu (2015), Shah et al. (2012), Shukla and Khedlekar (2015), Singh and Saxena (2013), Singh and Singh (2013), Tai (2013), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a), Widyadana and Wee (2012b), and Yang et al. (2013a)
12–14	Yang et al. (2013a)
12–15	Chung (2013a), Muniappan et al. (2015a), Sarker and Wu (2015), Singh and Saxena (2013), Singh and Singh (2013), and Yang et al. (2013a)
12–16	Chung (2013a), Guchhait et al. (2013a), He and Wang (2012), Jeang (2012), Li et al. (2015), Muniappan et al. (2015a), Sarkar and Sarkar (2013c), Sarker and Wu (2015), Shah et al. (2012), Shukla and Khedlekar (2015), Singh and Saxena (2013), Singh and Singh (2013), Tai (2013), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a), Widyadana and Wee (2012b), and Yang et al. (2013a)
12–19	Shah et al. (2012)
13–13	Agrawal et al. (2013), Bhunia et al. (2014a, 2015a,b), Bhunia and Shaikh (2015), Chung (2013b), Das et al. (2012, 2014), Ghiami et al. (2013), Guchhait et al. (2013b), Jaggi et al. (2015), Kumar et al. (2012a,b, 2013), Kumar and Singh (2015), Kumar Sett et al. (2012), Liao et al. (2012, 2013), Palanivel and Uthayakumar (2015b), Shabani et al. (2015), Singh and Vishnoi (2013), Singh and Pattnayak (2014), Singh and Vishnoi (2014), Valliathal and Uthayakumar (2013a), Yadav et al. (2012), Yang (2012b), Yang and Chang (2013), and Yu et al. (2014)
13–14	Ghiami et al. (2013) and Kumar et al. (2012b)
13–15	Singh and Vishnoi (2013)
13–16	Chung (2013b), Singh and Vishnoi (2013), and Yu et al. (2014)
14–14	Arianezhad et al. (2013), Cai et al. (2013), Chakraborty et al. (2015), Chen and Teng (2015), Chung et al. (2015), Dobhan and Oberlaender (2013), Duan et al. (2012a), Duan and Liao (2013), Egri and Váncza (2012), Fan et al. (2015), Ghiami et al. (2013), Giri and Bardhan (2012), Gunpinar and Centeno (2015), Ignaciuk and Bartoszewicz (2012d), Kumar et al. (2012b), Makkar and Jha (2012), Rijpkemaa et al. (2014), Tayal et al. (2014b), Wang and Lin (2012), Wu and Zhao (2014), Xiao and Xu (2013), Yang et al. (2013a), and Zhou et al. (2012)
14–15	Arianezhad et al. (2013), Cai et al. (2013), Chakraborty et al. (2015), Dobhan and Oberlaender (2013), Duan et al. (2012a), Duan and Liao (2013), Fan et al. (2015), Giri and Bardhan (2012), Gunpinar and Centeno (2015), Wu and Zhao (2014), Xiao and Xu (2013), and Yang et al. (2013a)
14–16	Arianezhad et al. (2013), Chakraborty et al. (2015), Dobhan and Oberlaender (2013), Duan et al. (2012a), Duan and Liao (2013), Egri and Váncza (2012), Giri and Bardhan (2012), Xiao and Xu (2013), and Yang et al. (2013a)
14–17	Gunpinar and Centeno (2015)
14–18	Dobhan and Oberlaender (2013) and Egri and Váncza (2012)
15–15	Annadurai and Uthayakumar (2012), Arianezhad et al. (2013), Bai et al. (2015), Bloomfield and Kulp (2013), Bottani et al. (2014), Cai et al. (2013), Chakraborty et al. (2015), Chaudhary et al. (2015), Chen et al. (2014b), Chen and Teng (2014), Chung et al. (2012, 2013, 2014), Chung (2013a), Chung and Cárdenas-Barrón (2013), Coelho and Laporte (2014), Das et al. (2013, 2015), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Duan et al. (2012a), Duan and Liao (2013, 2014), Duong et al. (2015), Fan et al. (2015), Firoozi et al. (2013, 2014), Ghiami and Williams (2015), Giri and Bardhan (2012), Giri and Sharma (2013), Goel et al. (2015), Gunpinar and Centeno (2015), Jeong and Leon (2012), Jia et al. (2014), Jörnsten et al. (2012), Kawakatsu (2013), Lee and Chung (2012), Lee and Kim (2014), Lesniewski and Bartoszewicz (2014), Luo et al. (2012), Mahata (2012, 2015b), Mahata et al. (2015), Muniappan et al. (2015a), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Roy et al. (2012), Sarkar (2013), Sarker and Wu (2015), Sazvar et al. (2012, 2014), Seyedhosseini and Ghoreyshi (2014a,b, 2015a,b), Shah and Patel (2012), Shah et al. (2013a), Shah (2015a), Shastri et al. (2013), Singh and Vishnoi (2013), Singh and Saxena (2013), Singh and Singh (2013), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Tat et al. (2013), Tayal et al. (2014a), Thangam (2012), Uthayakumar and Priyan (2013), Wang et al. (2012, 2014), Wu and Sarker (2013), Wu and Zhao (2014), Wu et al. (2014a), Xiao and Xu (2013), Yang et al. (2013a), Yu et al. (2012), Yu (2013), and Yu et al. (2013a)
15–16	Arianezhad et al. (2013), Bai et al. (2015), Chakraborty et al. (2015), Chaudhary et al. (2015), Chen et al. (2014b), Chung et al. (2013, 2014), Chung (2013a), Das et al. (2013, 2015), Dobhan and Oberlaender (2013), Duan et al. (2012a), Duan and Liao (2013), Ghiami and Williams (2015), Giri and Bardhan (2012), Giri and Sharma (2013), Goel et al. (2015), Jia et al. (2014), Jörnsten et al. (2012), Lee and Kim (2014), Luo et al. (2012), Mahata (2012), Mahata et al. (2015), Muniappan et al. (2015a), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Roy et al. (2012), Sarkar (2013), Sarker and Wu (2015), Sazvar et al. (2012), Seyedhosseini and Ghoreyshi (2014a,b 2015a,b), Shah et al. (2013a), Shah (2015a), Shastri et al. (2013), Singh and Vishnoi (2013), Singh and Saxena (2013), Singh and Singh (2013), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Tayal et al. (2014a), Uthayakumar and Priyan (2013), Wang et al. (2012), Wu and Sarker (2013), Xiao and Xu (2013), Yang et al. (2013a), and Yu et al. (2012)
15–17	Duan and Liao (2014) and Gunpinar and Centeno (2015)
15–18	Bloomfield and Kulp (2013), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Jeong and Leon (2012), Jörnsten et al. (2012), Luo et al. (2012), and Roy et al. (2012)
16–16	Amorim et al. (2013), Arianezhad et al. (2013), Bai et al. (2015), Belo-Filho et al. (2015), Chakraborty et al. (2015), Chao et al. (2015), Chaudhary et al. (2015), Chen et al. (2014b), Chiao et al. (2012), Chung (2013a,b), Chung et al. (2013, 2014), Claassen and Hendrix (2014), Dalfard and Nosratian (2012), Das et al. (2013, 2015), Dobhan and Oberlaender (2013), Duan et al. (2012a), Duan and Liao (2013), Dye and Hsieh (2013a), Egri and Váncza (2012), Garg (2015), Ghasemi (2015), Ghiami and Williams (2015), Giri and Bardhan (2012), Giri and Sharma (2013), Goel et al. (2015), Guchhait et al. (2013a), He and Wang (2012), Hsieh and Dye (2013), Jeang (2012), Jia et al. (2014), Jörnsten et al. (2012), Kazaz and Webster (2015), Kuthambalayan et al. (2015), Lee et al. (2014), Lee and Kim (2014), Li (2013), Li et al. (2014, 2015), Luo et al. (2012), Maddah et al. (2014), Mahata (2012), Mahata et al. (2015), Majumder et al. (2015), Min et al. (2012), Muniappan et al. (2015a), Nasr et al. (2014), Ng et al. (2012), Nilsen (2013), Paul and Voß (2014), Pal et al. (2014, 2015), Palanivel and Uthayakumar (2013a, 2014, 2015a),Pan and Li (2014), Pathak et al. (2013), Priyan and Uthayakumar (2015), Rahdar and Nookabadi (2013), Roy et al. (2012), Sangeetha et al. (2014), Sarkar et al. (2013), Sarkar (2013), Sarkar and Sarkar (2013c), Sarker and Wu (2015), Sazvar et al. (2012), Seyedhosseini and Ghoreyshi (2014a,b 2015a,b), Shah et al. (2012, 2013a), Shah (2015a), Sharma et al. (2015), Shastri et al. (2013), Shukla and Khedlekar (2015), Singh and Vishnoi (2013), Singh and Saxena (2013), Singh and Singh (2013), Srivastava and Gupta (2013), Tai (2013), Taleizadeh et al. (2015), Taleizadeh and Rasuli-baghban (2015), Tayal et al. (2014a, 2015), Tripathi (2014), Uthayakumar and Priyan (2013), Valliathal and Uthayakumar (2013b), Wang et al. (2012), Wang and Huang (2014), Wee and Widyadana (2012, 2013), Widyadana and Wee (2012a,b), Wu and Sarker (2013), Xiao and Xu (2013), Xu and Lu (2013), Yan et al. (2013), Yang et al. (2013a), and Yu et al. (2012, 2014)
16–18	Dobhan and Oberlaender (2013), Egri and Váncza (2012),Jörnsten et al. (2012), Kazaz and Webster (2015), Kuthambalayan et al. (2015), Luo et al. (2012), Ng et al. (2012), Nilsen (2013), Roy et al. (2012), and Xu and Lu (2013)
16–19	Dye and Hsieh (2013a), Kazaz and Webster (2015), Paul and Voß (2014), and Shah et al. (2012)
16–20	Chiao et al. (2012), Li (2013), Maddah et al. (2014), and Ng et al. (2012)
17–17	Beliën and Forcé (2012), Civelek et al. (2015), Duan and Liao (2014), Gunpinar and Centeno (2015), Haijema (2013, 2014), Lowalekar and Ravichandran (2013,

Table B1 (*continued*)

Key topic	Literature references to all (join) key topics
	2015), and Stanger et al. (2012a,b)
17–19	Beliën and Forcé (2012), Lowalekar and Ravichandran (2013, 2015), and Stanger et al. (2012a,b)
18–18	Abad (2014), Abdel-Malek and Otegbeye (2013), Baron et al. (2015), Bloomfield and Kulp (2013), Brito and de Almeida (2012), Carrizosa et al. (2016), Chen and Ho (2013), Chen et al. (2015), Deflem and Van Nieuwenhuyse (2013), Ding (2013), Ding and Yuan (2014), Dobhan and Oberlaender (2013), Drezner and Scott (2013), Egri and Váncza (2012), Fan et al. (2014), Hanasusanto et al. (2014), Hosseinipour and Sandoh (2013), Huang (2013, 2014), Jammernegg and Kischka (2013), Jeong and Leon (2012), Jörnsten et al. (2012), Kazaz and Webster (2015), Khouja et al. (2013), Kim et al. (2015), Kitaeva et al. (2015), Kuthambalayan et al. (2015), Levi et al. (2015), Luo et al. (2012), Murray et al. (2012), Ng et al. (2012), Nilsen (2013), Pal et al. (2013), Pando et al. (2013), Qin and Kar (2013), Qiu et al. (2014), Raza (2013), Roy et al. (2012), Sachs and Minner (2014), Sun et al. (2013), Tsai and Huang (2012), Wu et al. (2013), Xu and Ju (2012), Xu and Lu (2013), Xu et al. (2015), Yu et al. (2013b), Hui and Zhai (2014), and Zhang et al. (2014)
18–19	Kazaz and Webster (2015)
18–20	Hosseinipour and Sandoh (2013), Murray et al. (2012), Ng et al. (2012), and Tsai and Huang (2012)
19–19	Beliën and Forcé (2012), Chen and Chen (2012), Chen et al. (2014a), Dye and Hsieh (2013a), Giri and Maiti (2012), Huang (2012), Kazaz and Webster (2015), Lim et al. (2013), Lin et al. (2013), Lowalekar and Ravichandran (2013, 2015), Paul and Voß (2014), Shah et al. (2012), Stanger et al. (2012b), Stanger et al. (2012a), Ting (2015), and Wu et al. (2014b)
20–20	Al Hamadi et al. (2014), Atan and Rousseau (2015), Chiao et al. (2012), Disney and Warburton (2012), Graczová and Jacko (2014), Hosseinipour and Sandoh (2013), Jaggi and Mittal (2012), Jayaraman et al. (2012), Karmakar et al. (2015), Ketzenberg et al. (2014), Kouki and Jouini (2015), Li (2013), Lin et al. (2012), Maddah et al. (2014), Molana et al. (2012), Murray et al. (2012), Ng et al. (2012), Önal et al. (2015), Vijaya Laxmi and Soujanya (2015), Satheesh Kumar et al. (2012), Sazvar et al. (2013), Shophia Lawrence et al. (2013), Soysal et al. (2015), Tsai and Huang (2012), Weteling (2013), and Xu et al. (2014)

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