



Traditional Ecological Knowledge from the internet? The case of hay meadows in Europe

Rob J.F. Burton^{a,*}, Mark Riley^b

^a Centre for Rural Research, Universitetsenteret, Dragvoll N-7491 Trondheim, Norway

^b Department of Geography and Planning, University of Liverpool, 413, Roxby Building, United Kingdom



ARTICLE INFO

Keywords:

Traditional ecological knowledge
Hay-meadows
Google books
Traditional agriculture
Historical agricultural literature
Farmland conservation
Agri-environmental policy

ABSTRACT

Within Europe concerns are rising for the loss of traditional ecological knowledge (TEK) as agricultural communities continue to abandon traditional practices. TEK consists of a cumulative body of knowledge, practice and belief concerning environmental management (specifically agricultural management in Europe) that supposedly developed through generations of interaction between local communities and their environment. However, being based on largely oral accounts concern has arisen about the availability and reliability of TEK data – with some studies reporting inaccurate or contradictory information. In this paper we assess the potential of mainly pre-1800 agricultural texts to contribute knowledge to TEK studies. Since 2000, projects to digitise and make freely available out-of-copyright books from the world's libraries have made many of these pre-industrial agricultural texts easily accessible. These sources, we argue, provide a rich source of information. Specifically, we observe that knowledge emanating from contemporary TEK research can be found within this historical literature and question, therefore, whether contemporary European agricultural TEK is endogenously developed or represents vestiges of a wider pre-industrial agricultural knowledge system. Drawing on the English-language literature and using the case of hay meadow management, we provide examples of the types of information available, as well as detailing three examples of hay meadow management systems that are no longer associated with communities of practice – “fogging” of meadows, ant-hill management, and open-field, common or Lammas management. We conclude that while it may not be possible to reconstruct entire agricultural systems from literature-based knowledge, these sources can play an important role in complimenting and validating our understanding of traditional management systems.

1. Introduction

Over the last two centuries the industrialisation of agriculture combined with social, economic and environmental change has significantly altered rural communities in Europe as well as their management of the environment. Most notable has been the steady intensification of production culminating in the “productivist agricultural regime”, a period of modernisation characterised by “a commitment to an intensive, industrially driven and expansionist agriculture with state support based primarily on output and increased productivity” (Lowe et al., 1993:221). While the post-war productivist era effectively ended in the late-1980s due to a combination of oversupply, escalating costs, and environmental degradation (cf. Marsden et al., 1993) the new agriculture that emerged has shown stronger spatial irregularities with areas environmentally suited to agricultural production adopting more intensive practices, but agriculturally marginal areas often falling into disrepair (Wilson and Burton, 2015). The result has been a steady if not

rapid decline in traditional management practices in Europe's many agricultural communities such that few communities retain significant levels of traditional knowledge (Armstrong et al., 2017; Barthel et al., 2013).

The loss of these traditional management practices coincides with a period of increasing concern for the sustainable management of agroecosystems. Despite many attempts to halt decline, farmland in Europe and globally has witnessed both a steady decrease in species diversity and the loss of rare species over the last decades (e.g. Benton et al., 2003; Krause et al., 2011) – a process likely to be accentuated further with future climate change (Howden et al., 2007). This has led to questions being raised concerning whether current management approaches in agriculture are sustainable and, increasingly, whether returning to more traditional approaches might assist in limiting or preventing environmental decline (e.g. Bart and Simon, 2013).

The decline of traditional agricultural communities, combined with an increasing recognition of the importance of the environmental

* Corresponding author.

E-mail addresses: rob.burton@bygdeforskning.no (R.J.F. Burton), Mark.Riley@liverpool.ac.uk (M. Riley).

management knowledge they possess, is generating widespread concern that we are running out of time to gather the necessary traditional knowledge (e.g. Riley, 2008; Glasenapp and von Thornton, 2011; Kizos et al., 2013; Gómez-Baggethun et al., 2010, 2013; Babai and Molnar, 2014).¹ Central within this discussion is what has been termed “Traditional Ecological Knowledge” (TEK), which represents:

“a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.” (Berkes et al., 2000, p. 1252).

TEK is thus based on personal experience with landscape management that is often centuries old, developed *in situ*, communally stored and “mostly independent of western science” – even in the European context (Babai and Molnár, 2014, 124). Within Europe, researchers have explored a number of TEK systems – for example, traditional indicators of pasture condition in the Pyrenees (Fernández-Giménez and Estaque, 2012), traditional resource management in rural communities in Southwest Spain (Gómez-Baggethun et al., 2010), and weed and hazard control in Swiss alpine regions (Glasenapp and von Thornton, 2011). More recently, analyses have suggested that TEK may also be valuable in the process of adaptation and resilience to environmental and climate change (McMillen et al., 2017; Pearce et al., 2015).

Despite the growing recognition of TEK and its potential importance, the notion of traditional communities living simple lives in harmony with their environment, based on a superior form of experience-based knowledge and untainted by modernity is somewhat vulnerable to romanticism (see Kowalsky, 2014 for a useful summary of these critiques). Parallels can be drawn with the concept of the “rural idyll”. The “rural idyll” is a predominantly urban based perception of rural society (in developed economies) as a “*gemeinschaft*” community that is “simple, innocent and virtuous” – part of an idealised utopian countryside that is often distinctly different from the harsher reality (Somerville et al., 2015; Shucksmith, 2017, 1). It is these same “simple, innocent and virtuous” communities that we look to for TEK. This should raise concern that the notion of communities living in harmony with their environment may likewise be idyllicised and therefore the origins, validity and community basis of their knowledge may be questionable.

Indeed, a number of studies have questioned the reliability of TEK data. Bart (2010) for example, revealed that farmer accounts of TEK (how Phragmites – a wetland grass – responds to cessation of burning) were contradictory, ranging from stopping invasion to accelerating invasion. Don (2010) in observing that applying TEK to environmental management policy is problematic because it contains accurate and inaccurate information, asks why not simply apply scientific knowledge from the start? Likewise, Huntington (2000, 1273) warned of the danger of “overselling of TEK” which they observe “is sometimes wrong” as a result of misinterpretations both by the informants and the collectors of TEK. Critically they contend that to prevent it becoming incorporated into ecological studies as a token reference to local communities TEK should be “scrutinised as other information is scrutinised.” Bart (2010) similarly notes that for it to be useful in restoration ecology, researchers need to be more concerned about the validity of the knowledge.

The question of how to validate traditional ecological knowledge is thus an extremely important one. In general, the nature of TEK as

¹ Hernández-Morcillo et al. (2014) note from a review paper that of the 21 European studies that explored local trends in TEK, 14 specifically mentioned TEK loss. More broadly, Article 8 of the *United Nations Convention on Biological Diversity* (1992) states the intention to “preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity” (United Nations, 1992, p.6).

community-based locally-derived knowledge would suggest that, aside from subjecting practices to scientific examination, there is no way of validating it because there is simply no other source of information to cross-reference. However, in this paper we explore the potential utility of historical agricultural literature as a means of both confirming the validity of historically recorded practices and uncovering “lost” TEK. The paper is divided into five sections. First, we begin by presenting a brief definition of TEK. Second, we present a detailed methodology which introduces the sources and illustrates the processes (and pitfalls) involved in gathering and using such data. Third, we argue that TEK concerning historical management practices can be found in written sources and that these sources could have spread knowledge across the European continent during the early stages of industrialisation. Fourth, we illustrate what type of TEK is available on hay meadow management and present three examples of traditional hay meadow management systems that are no longer associated with traditional communities of practice – i.e. where the TEK is no longer practiced or culturally transmitted. Finally, we discuss the potential of historical sources for both confirming and complementing TEK derived from conventional field-studies in Europe.

2. What is TEK?

Berkes (2012) suggests that there is no universal definition of TEK, and notes that it is necessarily ambiguous. Whilst both the labels of ‘traditional’ and ‘ecological’ have been critiqued and, in some cases, substituted by different terms in other studies,² Berkes (2012) offers three facets on which TEK might be defined: 1) empirical, grounded, *knowledge* of species and environmental phenomena; 2) the *practices* that individuals carry out in relation to their environmental and livelihood activities; 3) the *beliefs* and values which shape how they interact with their environment. Put another way, TEK refers to “ways of knowing (knowing, the process), as well as to information (knowledge as the thing known)” (Berkes, 2012, p.8). In the context of this definition, several studies have suggested that TEK provides, or might provide, ecological knowledge relevant to the conservation of a range of plant, animal and marine species (see for example Biró et al., 2014; Huntington, 2000).

Evident within the literature is debate around the changing nature of TEK – both relating to its evolution *and* existence. Whilst Berkes (2012) suggests that TEK is a *dynamic* way of knowing – inter-generationally transmitted, but reworked within each generation – others point to examples where practices are thought to have remained largely unchanged for many years with people “who retain TEK [being] holders of a body of knowledge crafted for centuries by the specifics of completing tasks in the environment in which they have been living” (Drew, 2005, p.1287). The latter point has led to mixed opinions around whether actual examples of TEK can still be found – with conclusions ranging from TEK having completely disappeared (Biró et al., 2014), through existing as a memory more than in practice (Benz et al., 2000), to those noting fragments still remaining where the species in question have an importance for hunting and harvesting (Ziembicki et al., 2013).

The challenges to TEK’s survival are thought to be multiple. At its broadest level socio-economic change has meant “a lack of a receptive population to transmit and operationalize TEK” (Boafo et al., 2015, p.34). Interlinked with this, market integration of the majority of communities, and the mechanisation of agricultural practices in particular, has served to change the nature of agricultural knowledge and brought about practices which farmers had previously been unfamiliar

² These include alternative terms such as ‘experiential knowledge’ (Fazey et al., 2006) and ‘local knowledge’ (Ruddle, 1994). ‘Indigenous knowledge’ has also been used interchangeably with TEK in some writings, but Berkes (2012) suggests both critiques the idea that TEK is limited to just indigenous peoples and sees TEK as a subset of indigenous knowledge, more specifically focused on land-related knowledge.

with (Gómez-Baggethun et al., 2013). Whilst Berkes (2012, p.5) sees TEK as “firmly rooted in the reality of an accumulation of concrete, personal experiences, as opposed to book-learning”, debate continues around the extent to which TEK and western science represent different world views, and the extent to which the former can be seen as untouched by the latter (Frazão-Moreira et al., 2009; Davis and Ruddle, 2010). A further, more recent, challenge comes from within conservation science itself, which some argue has served to marginalise and over-ride TEK – both through ‘fortress’ conservation designations such as National Parks (Riseth, 2007) as well as a hierarchical view in which TEK is only used selectively in conservation management (Reo, 2011).

Whilst debate continues about the limitations of TEK, it is recognised that it may offer a “wealth of detailed context-specific observations of the dynamics of complex ecological systems” (Gadgil et al., 2003, p.206). Accordingly, there is a potential for historical observations that may be seen as ‘natural experiments’ where land users can see the outcomes of particular practices, and because “it is difficult to systematically conduct properly planned and replicated experiments in complex systems, local observations of such experiments can be of significant value” (Gadgil et al., 2003, p.205). Methodologically, therefore, TEK has been most often associated with the use of interviews, participant observation and direct contact with individuals and community groups in order to explore their practices, customs and rituals. However, this in itself creates multiple challenges including the availability of research participants (particularly as they often constitute an ageing population), the time and cost implications of such in-depth research, the challenges of memory and recollection as well as the verbal articulation of what may often be embodied knowledge (Biró et al., 2014; Fernández-Giménez and Fillat Estaque, 2012). It is here that the historical sources may be a useful addition to the discussion of TEK.

3. Methodology

In order to focus the literature search, traditional ecological knowledge of hay meadow management was selected as the topic for investigation. Semi-natural hay meadows are among the most biodiversity rich terrestrial ecosystems and are consequently the subject of considerable preservation efforts across Europe (Dahlström et al., 2013). These hay meadows have evolved over the centuries through an intricate management regime of regular mowing, the turning and drying of grass, only light applications of manure and a limited amount of ploughing (Riley, 2005; Norderhaug et al., 2000; Dahlström et al., 2008). However, biodiverse semi-natural hay meadows across Europe are increasingly under threat. Consequently, many contemporary investigations of TEK have examined traditional hay meadow management in the hope of slowing this decline (e.g. Glasenapp and von Thornton, 2011; Dahlström et al., 2013; Babai and Molnar, 2014; Babai et al., 2015). The high biodiversity value coupled with the fact that these management systems are some of the last of their kind being actively managed means that additional knowledge from literature-based sources could contribute significantly to reaching contemporary conservation goals.

It is important to offer definition of what we mean by meadows in the context of this paper. As Peterken’s (2013, p.17) detailed account suggests, the term ‘meadow’ has been used loosely both within its technical and more common application and meadows are “thus not clearly defined and unambiguous”. We use, here, the technical definition adopted by Peterken (2013, p.13) which sees meadows as “grasslands that are mown for hay, which means that they must be ‘shut up’ in spring and allowed to grow with grazing until they are cut in the summer”. From a biological perspective, it is this chance to flower, and the seed dispersion as part of the haymaking process, which has been challenged in recent years with the development of new grass preservation technologies such as silage (see Riley, 2006). Whilst pasture land may carry many of the same species, their management for

grazing, rather than cutting, is an important difference. Peterken (2013) uses the term ‘quasi-meadows’ to refer to areas of grassland which show similar biological characteristics to hay meadows – such as those found in woodlands, wetlands, gardens, roads and railway verges and church yards.³ Although in this paper we differentiate hay meadows from their ‘quasi’ types on the basis of their specific cutting and management for hay, a particular meadow type worthy of distinction are artificially-produced ‘water meadows’ which are included in our discussion. Mentioned as early as 1523 (see Rackham, 1986) and most commonly developed in Western England these meadows were constructed to manage flooding and irrigation patterns in order to maximise nutrient input, ground temperature, and grass growth and quality (often allowing an increased hay harvest) (see Cook and Williamson, 2007; Wade-Martins and Williamson, 1994).

Literature for the study was located using Loudon’s (1839, 1206–1214)⁴

Bibliography of British Agriculture” from the *Encyclopaedia of Agriculture* which covers the most important agricultural publications of the early industrial era.⁴ Initially, Google Books was used to search for online copies of the listed publications as it quickly became apparent that it provides the most extensive coverage.⁵ However, Google Books restricts its search to sources digitised by Google and thus excludes other digitised material such as *The Internet Archive* (<https://archive.org/>), the *Biodiversity Heritage Library* (<http://www.biodiversitylibrary.org>) and *The Hathi Trust Digital Library* (<https://babel.hathitrust.org/>).⁶ Consequently, publications that could not initially be located in Google Books were subject to a wider, more comprehensive, Google search.⁷ Despite Loudon’s (1839) claims to have enumerated the “chief” publications, online searching revealed that the bibliography lacked some relevant texts (referenced in other publications) as well as compiled works (e.g. Hale’s 1758 posthumous – *A Compleat Body of Husbandry*). In addition, only 22 of the 85 pre-1800 county surveys (see Section 4.1) were listed by Loudon. These additional sources were sought and located where possible.

Publications were limited to those in the English language – although Loudon also provides extensive bibliographies of French, German and Italian literature which may be available to others familiar with these languages. Because the study focussed on the TEK of hay meadows, the search excluded listed titles that suggested a focus on livestock (including cattle, poultry, and fish), books on tangential or unrelated agricultural issues (e.g. the combustion of hay stacks, road maintenance), books on foreign agriculture (e.g. tours to Ireland and France), and direct translations of foreign language books. However, it includes various dictionaries and encyclopaedia of agriculture which can contain lengthy accounts of agricultural practice. The books were gathered between April 2015 and April 2016, which is important to note as the process of scanning archives is not complete and thus it is possible that new publications have been added since the initial

³ In relation to woodland and meadows, species such as poplars, elders and willows were used to enclose meadows in some parts of Europe and their foliage used for leaf and twig fodder – a practice less common in the UK (see Halstead, 1998; Petit and Watkins, 2003; Watkins, 2014).

⁴ See Donaldson (1854) for a comprehensive publication list and biography of authors. Although John Claudius Loudon is perhaps best known for his work in botany and landscape design, he is also credited with reviving the term ‘husbandry’ and for his role within agricultural improvement (see Daniels and Watkins, 1991).

⁵ By 2012 the Google Books project had scanned 30 million out of copyright books, most of which are in a searchable text format (Matulionyte, 2016).

⁶ Note that we have found some of these sources to contain non-searchable pdfs that can be accessed in searchable form directly from Google. In many cases more than one copy is available and quality of scanning may vary.

⁷ In order to illustrate accessibility, we restricted the sources to publicly available databases that provide searchable pdfs. There are a number of other sources of searchable texts – in particular “Eighteenth Century Collections Online” (see <http://www.gale.com/primary-sources/eighteenth-century-collections-online>) that are licenced to institutions and provide a valuable additional source for those with institutional access. However, in our experience, the vast majority of key texts can be freely accessed elsewhere.

Table 1

Availability of publications from online sources as listed in Loudon (1839) as well as additional papers not listed in Loudon's bibliography.

Century	No. of publications not found online	No. of publications found online	% of publications available (Loudon)	Additional publications
1500 to 1599	1	2	67%	1
1600 to 1699	9	11	55%	3
1700 to 1799	27	168	86%	59

gathering of sources.

Table 1 details the number of pre-1800 publications listed in Loudon (1839) that could be located online along with the number that could not be located.⁸ As might be expected, some of the older publications (pre-1700) proved difficult to locate although two of the three 16th Century and 55% of the 17th Century publications were available. A dramatic increase in the number of agricultural publications in the 18th Century (particularly in the second half of the century – see Fig. 1) is matched by the greater availability of publications with, in this case, 86% of the listed publications freely available online. Publications after 1800 became so numerous that it was no longer feasible to comprehensively search for all of them. At the same time, their value as sources of TEK rapidly declined due to an increasingly scientific basis to agricultural reporting. Loudon (1839, 1206) himself was of the opinion that advances in chemistry, animal and vegetable physiology “which have taken place chiefly since the commencement of the present century” meant that publications prior to 1830 were “of very little value” from a scientific perspective but were “to be considered as historical documents of the progress of opinions and practices”. Post-1800 sources were also gathered on an ad hoc basis and used in the analysis as many, particularly those from the first two decades of the century, referred to traditional practices.

Publications were downloaded as pdfs into a file folder. In the vast majority of cases texts from Google and others are scanned in a searchable form using text recognition. The few files that were not searchable were searched manually for relevant information and notes taken of relevant sections. Where information was particularly relevant the text recognition facilities of Microsoft OneNote were used to convert screenshots of non-searchable text into searchable text – although this was not frequently necessary. Once gathered, the pdfs were searched for key terms (e.g. “natural meadow”, “old grass”, “hay seed”, “hay cutting”, “meadow management” and so on) in an open process using the Copernic Desktop Search program. Copernic enables rapid searches within the text of multiple documents and identifies those where the search term is found. In this way the assembled library can be rapidly searched in a manner that would simply have been impossible for scholars prior to the development of digital content. The literature on these issues was then assembled thematically and reviewed.

Known problems with this process include that not all scanned books are made freely available as a result of Google's geographic availability policy and that some content, in particular fold-out maps, is missing (Tobin, 2008). However, while there are some issues with the legibility of the pages depending on the quality of the source publication, the text font used, and the scanning process, a recent study found legibility errors on only 1% of pages for Google Books (James, 2010). This figure, however, appears to vary significantly depending on the age of the documents. In many cases, very early documents are not written with standard English spellings and, perhaps more importantly, were poorly printed leading to problems with recognition of the scanned words. In these cases, spelling variations were used to locate relevant sections. An additional concern is that there is considerable

⁸ Note that each volume of a multi-volume set was counted as an individual book. The figure includes 30 out of 33 vol of the journal “Annals of Agriculture” from 1784 to 1799. In addition, the County Surveys to the Board of Agriculture (see Section 4.1) account for 22 of the found publications and 47 of the additional publications from the 18th Century (1793–1799).

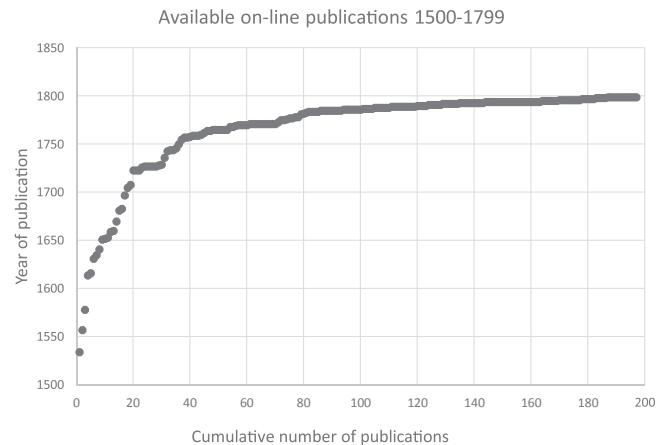


Fig. 1. Number of pre-1800 publications available on-line by the year of publication.

plagiarism in the historical agricultural literature with authors commonly simply copying earlier accounts (see Grigg, 1967). In our study, the relatively comprehensive nature of the assembled database coupled with the use of a desktop search engine meant that plagiarised works could be easily located. However, a search of a less comprehensive database may not locate the original author.

A further issue that emerged concerned the use of search terminology. In particular, the term “hay meadow” itself (now common in the academic literature) was almost entirely absent from the historical literature as the cutting of hay was generally the defining feature of a “meadow”. Similarly, there was no reference to habitat, of any type, being “semi-natural”. There was also some disagreement over the meaning of terms. For example, Brown (1799) notes that the terms “old pasture” and “natural meadow” are sometimes used interchangeably (incorrectly in his opinion), while in Scotland “old grassland” may be termed “meadow” even when it “is very seldom cut for hay” (Kerr, 1809, 29). Rham (1845, 332) similarly observes in general that grassland can be termed meadow land “if the natural herbage is permanent, and frequently made into hay”. To find sections on “hay meadow” management, terms including “meadow”, “natural meadow”, “old grass”, “old grassland”, “natural grass” and “natural pasture” are required. Similarly, the term “upland meadow” has shifted from its traditional meaning of any meadow not subject to flooding (e.g. Mortimer, 1708; Middleton, 1798), to meadows “largely confined to the valley floors and lower slopes of upland areas between 200 and 400 m elevation, where extensive hay meadow treatment has been applied in a sub-montane climate” (Jefferson, 2005, 322; also Critchley et al., 2007).

A final note on the methodology concerns the need to account for the perspectives of the authors. In particular, while Loudon (1839) considered all pre-1830 agricultural literature as “historical documents”, at the time of their writing authors were recording “modern” practices. This is evident even from the publication titles – for example, Ellis's eight book series on “The Modern Husbandman” was published in the mid-1700s (e.g. Ellis, 1743, 1744a, 1744b) while 50 years later Donaldson (1796) wrote a four book series similarly entitled “Modern Agriculture”. In analysing the literature it becomes quickly apparent that identifying which knowledge, practices and beliefs are “traditional” is exceptionally difficult. In the end we identified

“traditional” practices through the eyes of the authors, i.e. traditional practices were those the authors viewed as old, customary or traditional whether their observation was made in the 16th, 17th, 18th or 19th Centuries. In order to obtain this perspective, we had to read many sources “against the grain” – picking out layers of detail below the broad narrative which the sources’ originators intended (Eagleton, 1986) to account for the over-representation of novel practices (Brassley, 1996) and strong bias towards improvement (Grigg, 1967).

4. TEK and the British agricultural literature

4.1. Industrialisation and the historical gathering of TEK

The current concern for collecting knowledge of traditional agricultural systems is not unique in history. The industrial revolution of the late-1700s and the corresponding “agricultural revolution” that accompanied it⁹ led to a significant change in agriculture with improvers such as Arthur Young and John Sinclair seeking to mirror the success of manufacturing and commerce by turning subsistence agriculture into a productive modern industry (Young, 1793; Sinclair, 1802). With agricultural knowledge widely dispersed across the country agricultural improvers in the UK began to search for the best practices across the regions. For example, William Marshall (1789, x) in a publication on *The Rural Economy of Gloucestershire* reports of agriculture in the United Kingdom at the time that:

“The objects and operations of husbandry, are, in number and species, the same, or nearly the same, in every quarter of the kingdom. But the methods of obtaining the objects, and of performing the operations, are infinitely various. *To catch the variations, whenever they are sufficiently marked, whether with excellency or defect, is one of the main objects of the part of the plan I am now executing.*” (emphasis added)

In the United Kingdom the establishment of the Board of Agriculture in 1793 led to the commissioning of a series of county surveys. John Sinclair’s 1793 speech to Parliament on the establishment of the Board (printed in the *Annals of Agriculture* – Young, 1793) outlined the purpose of the surveys (county reports) as:

“by agricultural surveys, carried on under the auspices of such a Board, every fact or observation, known in this country, connected with the improvement of the soil, or the stock it maintained, would soon be collected. The circulating of that information could not fail to be attended with the happiest consequences.” (134)

While the purpose of the surveys was to promote agricultural improvement (and this has undoubtedly led the reports to overstate the advancement of agriculture at the time – Grigg, 1967), uncovering “every fact or observation known to this country” gave the surveyors a wide remit to record data concerning traditional management systems. The publishing of the reports,¹⁰ as discussed at a meeting of the Board of Agriculture on 20th June 1797 would not only explain the “general state of the county” but as a “respected foreign honourable member (Mr. Voght, of Hamburg) observed:

“we shall have collected the operations of an art, which have been hitherto neglected in the routine of practical husbandry, or have been imperfectly communicated by tradition; and many useful facts and observations will thus be rescued from oblivion, which otherwise might have been lost.” (Sinclair, 1797, 352)

⁹ Researchers consider there to have been multiple agricultural “revolutions” after the 1500s (Overton, 1996; Allen, 1999).

¹⁰ At least two reports were published for each County – one in the early 1790s and one in the late 1790s or early 1800s. As the second report provided a more detailed picture of agriculture (often incorporating and extending the first report) the second reports are generally more useful sources of traditional knowledge.

Gathering information on agriculture in the late 18th Century was, however, a rather haphazard process. Prior to the county surveys, reports were often personalised descriptive accounts – for example, Arthur Young’s travel dairies describing tours through the South, East and North of England (e.g. Young, 1769, 1771a,b) – that examined the “present state of English husbandry”. Surveyors employed to undertake the county surveys were provided with a standard format for recording data. However, they came from a variety of educational backgrounds ranging from farmers to priests and, consequently, their specialised knowledge and interests (as well as their sometimes scathing views on traditional agricultural practices) are often discernible from the content of the reports. Details of traditional agricultural systems were provided in many cases for the primary purpose of emphasising the comparatively greater value of new methods, while any activity recorded that resulted in a higher yield or profit was considered worthy of discussion and/or replication.

4.2. Could the British literature contain TEK of wider relevance to European TEK?

Our assessment above suggests that TEK (in the form of descriptions of agricultural management practices) has been recorded in the historical British literature, but leaves open the question of whether these reports were simply for national consumption or were part of a wider European knowledge network. One interesting observation made during the course of the research was that traditional management practices reported as TEK could be found in written form in the historical literature. For example, Babai and Molnár’s (2014, 129) study of TEK amongst Csángó farmers in Romania revealed a number of detailed practices relating to the management of hay meadows which they attributed to the farmers’ “deep embeddedness” in their ecological systems. However, many of these practices also appear in the early agricultural literature. For example, the burning of moss and spreading manure thinly over the surface of hay meadows in order to suppress moss growth (noted by Babai and Molnár (2014, 128) as “not known from elsewhere”) can be found in Mortimer (1708, 59 – Hertfordshire farmers “make a very great improvement of sandy lands that are much given to moss, by burning of the moss”) (also Lisle, 1757; Du Monceau, 1759) and Baily & Cully (1813, 315–re: Westmorland farmers “the dung that remains after manuring for the barley crop, are always laid upon the hay grounds, and are thought considerably to retard the progress of the moss”).

In a sense this finding is reassuring. The current management practices captured in Babai and colleagues’ research can be confirmed as part of a traditional management approach – albeit one that is perhaps not unique to the Romanian situation. Comparability between contemporary TEK and historical management practices has also been noted in Sweden where Dahlström et al. (2013, 203) observe that:

“The correspondence between pre-industrial meadow use in Sweden and the current use in Romania is striking. Even when taking into account climate and other differences, Romanian practices may provide insights into Swedish historical practices.”

However, the widely repeated assertion that this knowledge is uniquely and endogenously developed by communities through their deep embeddedness with the local environment, is undermined by the existence of identical practices hundreds of kilometres distant and in a completely different cultural/environmental context. This could be a case of two (or more) separate communities simultaneously developing the same knowledge in response to their environment. However, there also exists the possibility that such TEK does not have endogenous origins, but rather represents the vestiges of a knowledge network (including formalized written knowledge) that was once more widespread. We suggest three reasons for believing that there could be such a connection between the historical literature and contemporary TEK in Europe.

First, studies of the relationship between traditional knowledge and codified scientific knowledge suggest that there is no distinct boundary between the two – traditional knowledge readily absorbs knowledge from codified sources and vice versa (Dove, 2002). For example, oral ethnobotanical knowledge has been found to be complemented through the addition of scientific information such that “the strict separation between local traditional knowledge and that which ‘comes from books’ has no meaning at a local level” (Frazão-Moreira et al., 2009, 35; Leonti, 2011). Leonti (2011) further argues that the invention of printing and mass media greatly assisted in “eliminating the complex steps of cultural transmission otherwise essential in stratified societies” (552). Hernández-Morcillo et al. (2014, 4) concur that local combinations of scientific and traditional knowledge enables TEK to be transmitted, with published sources in literate societies (such as Europe) having “immediate and prolonged effects” on TEK transmission. Thus, it can be argued that if historical scientific literature absorbed pre-existing knowledge in the 18th and 19th Centuries (Ellen and Harris, 2000) it could equally have transmitted it.

Second, in the 1700s efforts were underway to transfer “scientific” information from books to the wider farming communities. This process, however, was clearly very problematic. A number of commentators believed the general farming population clung to old customs and was not sufficiently educated to understand the new practices. For example, Henry (1771, 96) asserted that “the knowledge that is gleaned from much reading is rather apt to perplex and bewilder the farmer, than to direct his practice, or to improve the main branches of his profession”. Verral (1799, 100) similarly observed of farmers in his region:

“Books treating scientifically on agriculture are of little, if any utility, to the small wealdish [referring to the Weald – a geological feature in Sussex] farmer. For want of education, his capacity, expanded only in a very limited degree, is not capable of understanding the improving lessons genius exhibits ...”

However, there were means of transferring knowledge from the written literature to remote farming communities. By the mid-1700s many “county societies” had emerged across Europe with, reportedly, over 30 in France, several in Switzerland, and others in Leipzig, Wirtemberg, Hannover, Zurich, Heidelberg, and Stockholm (Weston, 1773, iii) as well as Brecknockshire in Wales (Anon, 1765). The primary objective of these societies was to improve the general condition of agriculture of their region through learning and then teaching “common farmers” (Anon, 1765) or “those plain unlettered-men” (Somerville, 1800, 40) by example. Indeed, as Goddard (1983) has later commented, much effort was made to disseminate the findings being presented in the agricultural press to those farmers thought unlikely to read it first-hand. The royal houses of Europe were also involved in this dissemination. For example, Young (1778–reprinted in Annals of Agriculture, 1793) observes that the kings of Sweden, Prussia, Denmark and Sardinia all established schools throughout their dominions “for the education of much inferior classes for husbandry” (p 247).

Third, there is evidence of widespread dissemination of agricultural knowledge between the nation states of Europe.¹¹ Agricultural publications of the time provided bibliographies in multiple languages. For example, Von Münchhausen (1766, pages 9–28) in “Der Hausvater” lists German, English, French, Italian, Spanish, Dutch, and Swiss agricultural publications for German audiences. Key texts were translated. For example, Chalmers (1814, 86) observes that a two volume publication “Elements d’ Agriculture” by Duhamel Du Monceau (1762) the “father of intelligent agriculture in France” was available in German, Spanish, English and French. The importance of food security in an era

¹¹ The objective was the spread of agricultural innovation not traditional methods. However, at over 200 years old this pre-dated much of the scientifically derived sources of agricultural knowledge.

of regional conflict also contributed to the spread of agricultural knowledge (see Young, 1771b). A review in the Agricultural Magazine (Anon, 1803, 142) reports that “Instructions elementaires d’Agriculture” was written by the Italian Adam Fabroni on the behest of Archduke Leopold II “who had requested him to write some elementary lessons suited to the farmers and peasantry in his dominions” – dominions that included Germany, Austria, Hungary, Bohemia, Croatia, Dalmatia and a number of other European provinces.

We do not contend that this analysis should lead us to conclude that knowledge from British agriculture has influenced the management of Romanian hay meadows as in Babai and Molnar’s (2014) study. Rather we use it to illustrate how the *opportunity* and *incentive* existed for both scientific and traditional knowledge to be recorded and transferred to even remote areas of Europe over a long period where traditional knowledge dominated. Whether this knowledge then became integrated with existing TEK is a moot point. However, we cannot make the assumption that because a small isolated community employs “traditional” agricultural methods with no local written record that these methods have been developed endogenously through generations of interaction between the local community and local environment. The often very limited number of people left holding the TEK is seen as a problem by researchers in terms of the loss and unreliability of data (e.g. Tibby et al., 2007; Bart, 2010), but where the knowledge is limited to a few isolated pockets it could also contribute to a false impression that the knowledge was not previously more widespread.

5. Can we obtain useful TEK from historical literature?

If we accept that TEK was incorporated within the historical literature and that knowledge may have been spread both across the countries of Europe and to uneducated farming populations within these countries, the next question to address is what information can be obtained from these sources that might be useful to researchers? This next section looks at two issues. First, given a reported increasing emphasis on grassland restoration ecology across Europe, we briefly examine what type of information is available that may assist researchers in restoring hay meadows. This is not intended to be a comprehensive assessment, nor are we in a position to judge how useful the knowledge may be in practice as this is likely to depend on specific circumstances. Rather it is to illustrate to those with an interest in restoration ecology or involved directly in preserving or recreating these habitats the type of information that might be obtained from an in-depth assessment of the historical literature. The second part looks at three “lost” (in the TEK community context) systems of hay meadow management that emerged during the analysis, namely; management through “fogging”, management of ant-hill meadows, and management of hay meadows as common fields. In this section we explore whether sufficient detail exists in the literature to “restore” lost systems.

5.1. Is internet-based TEK useful for restoration ecology?

Texts on restoration ecology frequently refer to the post-WWII era as the period where the majority of semi-natural hay meadows and grasslands were lost as a result of intensive agriculture in Europe (e.g. Rouquette et al., 2009; Bullock et al., 2011; John et al., 2016). However, as we have illustrated above, intensification accompanying “modern” agriculture was well underway even in the late-1700s as the old methods that were “traditional” to the authors of the time were being replaced by more “modern” beliefs, knowledge and practices. While we should perhaps not seek to restore hay meadows to their pre-1700s condition (see discussion in Section 6), it is important to remember that the degradation of hay meadows through “modernisation” began in the 18th and not the 20th Century. Hay meadows located around cities appear to have been particularly prone, initially through intensification (although many around large cities were already intensively managed by the late-1700s – see Middleton, 1798) and later

through urban sprawl into the peripheral regions (e.g. the reports to the Board of Agriculture for Middlesex noted that some of the best hay meadows around London were at Islington, Marlebonne, Paddington, and Pancreas (Foot, 1794; Middleton, 1798) – now Victorian era railway stations). More generally, however, it has been observed that agricultural intensification in fertile regions has meant lowland hay meadows and semi-natural grasslands across Europe have declined dramatically (Ridding et al., 2015).

We contend here that restoration ecology could benefit from a more comprehensive engagement with historical literature. The dramatic loss of semi-natural grassland has led to an increase in restoration efforts across Europe, led by the rapidly growing field of restoration ecology (John et al., 2016; Török and Helm, 2017). It has recently been argued that this field should turn towards ecological theory to answer the practical questions concerning how to restore semi-natural grassland environments (Török and Helm, 2017). However, while this is clearly an essential element, we argue restoration ecology (which prides itself as an inherently interdisciplinary field – Tress et al., 2006) may also benefit from a simultaneous return to analysing historical agricultural texts. We do not contend that these sources provide a “guidebook” that can simply be implemented to restore semi-natural pastures and hay meadows – much more intensive scholarship is required in order to locate and validate relevant TEK – however, if investigated properly, they may be able to provide information necessary to assist in the creation and restoration of the species rich semi-natural grasslands of today.

As the objective here is not to locate and analyse this information, but to point researchers to the sources, we will not go into this in depth. However, the remainder of this section provides an indication of the type of information available within these sources (although it is by no means comprehensive).

Preparation of hay meadows – The clearing of hay meadows of obstacles of “every thing that may injure the stock, if pastured, or that can obstruct the scythe.” (Sinclair, 1832, 414) was historically an important part of meadow preparation that has also been noted as part of contemporary TEK (Babai and Molnár, 2014). What is not so commonly recognised is the role village communities might have historically played in meadow preparation. The act of trampling the meadow was believed to have many advantages such as driving away moles, “settling the roots of plants” and destroying moss (Mavor, 1812, 64). To this end, an early form of football (“camping”) was encouraged for hay meadows as a means of meadow preparation (Tusser, 1580, reprinted in Payne and Herrtage, 1878) while others tried, reportedly with limited success, to use bull baiting events to prepare meadow grounds (Ellis, 1746). This integration of village life and agricultural management could have had a significant effect on meadow habitats as moderate anthropogenic disturbances (such as trampling) can positively influence species richness and habitat diversity (Selvi and Valleri, 2012).

Fertilisation – Kirkham et al. (2008) observe from a study in Cumbria and Monmouthshire (UK) that our understanding of what constitutes sustainable practices in the application of manures to hay meadows is poorly understood. Historical sources provide a wealth of information on fertilisers – from intensive dung-based manuring around large towns and cities (Middleton, 1798), to application of coal ash and soot which performed a secondary role of moss control (Worlidge, 1681; Ellis, 1744a, 1750a; Donaldson, 1796; Young, 1804a), and the application of farmyard manure, lime and other mineral fertilisers and wastes (including road scrapings and mud from the bottom of ponds) to farms too distant to make urban fertilisers economically viable – although this was only done occasionally if at all (Dickson, 1807 v2). Farm manures were generally mixed and/or composted before application. There are many descriptions of how manure was mixed for application to pasture in the literature (e.g. Laurence, 1727; A Country Gentleman, 1755; Hale, 1758) as well as details of the quantities of manure spread (e.g. Horne, 1830). Distant farms of the period also often employed folding as a means of manuring hay meadows. Folding is the

practice of keeping sheep overnight in a confined (temporarily fenced) area in order that the land be improved by grazing, manuring, trampling, urination, “the warmth of their bodies” (Ellis, 1750b, 34) and “perspirable matter exuded from their fleeces” (Horne, 1830, 346). The folding of sheep onto hay meadows is still practiced by the Csángó farmers of Romania (Babai and Molnár, 2014).

Determining cutting dates for hay – Cutting dates for hay meadows are critical as they affect species richness with, in particular, early cutting being associated with reduced biodiversity (e.g. Critchley et al., 2007). Although recommended standard cutting dates may be obtained (e.g.) emphasis in the literature is strongly placed on phenological indicators of when to cut to ensure the meadow is “in full sap” (Vancouver, 1810, 270) and before the grass begins to wither (). For example, ‘Pennie (penny)’ or ‘rattle’ grass (sp. *Rhinanthus*) has been widely used as an indicator in Europe (e.g. Høeg, 1974; Tunón and Kvarnström, 2015) and has also been noted in the historical British literature (Best, 1641; Ellis, 1750b; Baxter, 1839). Further, a wide array of additional factors that can influence mowing date were observed. For example, labour availability (due to coincidence with other farm tasks – Fitzherbert, 1534; Stephens and Norton, 1851), the need to improve meadow condition (Rudge, 1807; Rham, 1845), and the need to gather seed (Boys, 1796; Middleton, 1798). Studies suggesting cutting dates should be variable from an ecological perspective for traditionally managed hay meadows (e.g. Smith and Jones, 1991; Eriksson et al., 2015) thus have a basis in the historical literature.

Ploughing and reseeding hay meadows – The current increase in hay meadow creation and restoration efforts in Europe (John et al., 2016; Török and Helm, 2017) suggests that TEK outlining how to create new or reseed old natural meadows would be a useful addition to existing scientific knowledge. There is frequent mention of how to reseed ploughed meadows and increase the biodiversity of existing meadows in the historical literature because of two debates going on at the time. The first involved the issue of whether better quality hay could be obtained from ploughing up and reseeding “old grass” (see Sinclair, 1801 for an overview) and the second whether it was better to use “artificial grass” (such as rye grass, burnet, clover, timothy) or a greater variety of endogenous “natural grasses” (see Curtis, 1789, 1812).¹² Enhancement of existing hay meadows may also be possible using historical techniques or equipment. Edwards et al. (2007) observe that management tools and practices that might commonly have been used in the past (hay strewing, brush harvesting of seed and soil disturbance) can contribute to enhancing the biodiversity of meadows. As many of the texts reviewed outlined these tools and practices for farmers there is potentially a vast array of information on traditional practices to assist in enhancing the biodiversity of hay meadows – or at least assist us to understand how biodiversity in hay meadows was maintained historically.

As a way of summing up, the following statement illustrates the way information on hay meadow management regimes is commonly presented in the literature – with dates, practices, meadow type (natural grass) and an approximate location provided. Rudge (1807) reports for the natural grass meadows in the Cotswold Vale “the whole lowlands from Stratford-upon-Avon to Bristol” (12) management practices as follows:

“In the Vale, where the natural grasses chiefly prevail, the pasture is hained up, if intended for early mowing, about Candlemas; if otherwise, about Lady-day: the cow and other animal excrements are well beaten with the prongs of the pitchfork, and dispersed, as also the hillocks of mould which have been raised by the moles since

¹² Curtis (1789) (a botanist by training) wrote in the *Annals of Agriculture* on “General observations on the advantage which may result from the introduction of the seeds of our best grasses” – an article in which he outlines how to introduce native grass species to meadows to overcome the growing dominance of rye grass monoculture – and later published a book on “Practical observations on the British grasses especially such as are best adapted to the laying down or improving of meadows or pastures” (Curtis, 1812).

last mowing: stones, and other rubble, are picked up by women and children, and carried away. If manure of any kind has been laid on, it is brushed with thorns, fastened to the upper side of the harrow; and, where the land is not too wet, it is afterwards rolled.” (Rudge, 1807, 189)

This is accompanied by additional details of the practices involved in the harvesting of the hay, techniques for gathering hay in poor weather conditions, the way hay making techniques varied depending on the species composition of the meadow, the implements used to harvest the hay, the way hay-stacks were constructed, and what was done with the aftermath. This type and level of detail is relatively common in the county surveys where the objective was to gather facts about agriculture – but less so in other publications. As with all historical publications, while general information on “improved” agriculture is readily available, finding information for a specific region on a specific topic associated with traditional management is more problematic. Nevertheless, even if no reference is found, searching for such references could be an important first step in understanding traditional meadow management where reconstruction or restoration is intended.

5.2. Lost systems of hay meadow management?

As noted above, the number of communities with TEK remaining in Europe is very limited and declining rapidly, with few remaining communities following traditional management practices (Armstrong et al., 2017; Barthel et al., 2013). This raises the question of whether “traditional” systems of hay meadow management located in the intensively farmed spaces between areas of traditional management have been completely lost over the last 200 years – or at least are only present as remnants outside of their cultural environment. While in many cases there may be no means of gathering information about these practices using the standard techniques for gathering TEK (i.e. interviews, participant observation and direct contact with individuals and community groups), from the historic literature it may be possible to explore lost TEK such that these practices can be better understood (if not recreated). Three types of what appear to be meadow management systems were identified in the literature, namely: fogged meadows, “ant-hill” meadows, and “open-field”, “common” or “Lammas” meadows.¹³

5.2.1. Fogged meadows – managing without hay-making

County surveys from the Welsh counties of Cardiganshire (Lloyd and Turnor, 1794) and Pembrokeshire (Hassal, 1794) recorded an “ancient” (according to Burke, 1834) practice of meadow management called “fogging”. Davies (1815), in his summary report for South Wales, provides perhaps the most comprehensive description of the practices, benefits, and geographical distribution associated with fogging – as well as comments by local landowners/farmers. He notes that fogging was once relatively widespread but, at the time of the survey, was “mostly confined to Pembrokeshire, part of Cardiganshire, and those parts of Carmarthenshire which join the two former counties” (547).¹⁴ Lloyd and Turnor (1794, 17,18) in the first county report for Cardiganshire described fogging as:

“Our upland ground being so dry and sound, that no animal can in the wettest weather make an impression on the surface, and naturally

running into white clover and good grass; when not too much exhausted, it is the practice with many to set apart many acres for fog ... As early in May as we can, the fields are shut up for the summer season, with no other intention than eradicating dock, or cutting down thistles, etc. In that state they continue until November or December; when all the stock is turned in, and every animal is in excellent condition, without the aid of hay, straw, or oats, and the butter is as good as in any part of the year. The frost sweetens the grass, and snow does not injure it; but while it is buried, dry food must be resorted to. In the spring of the year, young shoots of grass are very forward, under the shelter of the old, and both together are eaten with avidity. The land which was before mossy, from being over-stocked and grazed too bare, is soon filled with palatable and abundant food, and the moss disappears without the aid of the plough, or surface manure; it betters every year and I am inclined to think the best acre of hay will not keep more stock, or in such good condition, as an acre of fog, with the additional advantage of avoiding the risk, and saving the expense of hay-making and manure.”

The key benefit of fogging for livestock production appears to have been to ensure an uninterrupted supply of food for livestock at a time when other sources of feed were beginning to run short (Lloyd and Turnor, 1794; Evans, 1804). This may have been, in part, an adaptation to difficulties of making hay for the livestock which was “seldom done well in that humid climate” (Anon, 1855, 507) while the spring was generally late (Read, 1849). Fogging reduced the risk of a failed hay harvest with very little effort on the part of the farmer. However, numerous other benefits for the meadow were ascribed to it. In particular: reducing the presence of moss (Hassal, 1794), thickening the vegetation (Young, 1804b), enabling livestock to spread manure directly onto the pastures, preventing the regrowth of thistles and dock, and replenishing the soil with seeds (Edward Williams – comments in Davies, 1815).

Fogging is a useful example through which to consider TEK more broadly. References in the literature to this practice are sporadic – with mention in the early 1900s (Hall, 1914) and again in the 1940s (Davies, 1948).¹⁵ At one level, this may give an insight into the potentially piecemeal and sporadic nature of its application. More fundamentally, however, these written sources might stand as evidence of the dynamic nature of TEK and also act as a caution against using TEK derived from oral sources uncritically. Davies’ (1948) account of fogging focuses entirely on the importance of leaving the grass standing for late autumn/early winter grazing (seeing it as preferential to making poor quality hay in wet summers), with no mention made of the qualities of restoration and land resting we hear in the earlier accounts. We might see this as an example of TEK’s adaptive nature in changing socio-economic conditions (e.g. Fernández-Llamazares et al., 2015) – with the influx of scientific understandings on meadow management at this time meaning that salvaging of the grass crop is the only facet of this fogging TEK which survives. Taking this logic forward, this one example would lead us to question whether oral accounts of other ‘traditional’ practices may similarly be partial relicts of a much more detailed set of practices.

5.2.2. Management of ant-hill meadows

A second unusual meadow management system was recorded in the original county report for Buckinghamshire. James and Malcolm (1794, 47) observed that many dairy farmers “wedded to old customs” maintained large numbers of anthills on their meadows in the belief “with much seeming confidence” that anthills enhanced production due to the larger surface area on the field, produced an earlier flush of spring grass on the south side of the hills, and sheltered lambs in the spring. In the second report for Buckinghamshire, Priest (1810, 284) also observed that farmers in this region allowed anthills “in size scarcely to be

¹³ Note there were suggestions of other systems. For example, Philo-Gramen (1765, 164) contend that as the best hay is made from a mixture of grasses with different maturing dates, farmers should sow their meadow species “according as they ripen, and afterwards mix all together in the stack” in order to extend the hay-making period. However, we found no evidence that this was a traditional practice or, indeed, ever practiced. It may have been an attempt to reconcile strengthening beliefs about the greater productivity of monocultural ‘artificial grasses’ with traditional beliefs concerning the value of maintaining plant diversity in hay.

¹⁴ Fogging was also observed to be practiced (although rare) in Suffolk (South England) (Young, 1804b) and the Vale of Skipton in Yorkshire (North England) (Rennie et al., 1794).

¹⁵ It is superseded at this point by the rapid spread of silage production.

credited” to form on the pastures such that “they are found not scattered here and there, but nearly as thick as the pasture can hold them from the tops of the ridges to the furrows”. This, he noted, created an environment whereby water gathered in the unmoored furrows and encouraged the growth of rushes. Priest viewed these as a “pernicious weed”. However, when asking the farmers about them he noted

“... more than one farmer informed me, that such rushes were valuable, and they should be very loth to exchange them for what others might esteem more productive plants, since such rushes served them instead of straw for their yards” (285).

This practice of preserving anthills as part of the management of meadows appears to have been more widespread. [Boys \(1794, 398\)](#) notes that some graziers of Romney Marsh (Kent and East Sussex) “will not suffer the ant-hills to be destroyed, under an idea, that there is more grass grows between them, by means of the shelter they afford”. [Ellis \(1744b, 115\)](#) similarly observed that in Hertfordshire as well as Buckinghamshire anthills had long been tolerated by landowners and farmers alike because they were “were under the silly notion of their increasing grass in feeding meadow-ground” and it was only in the 1720s that “part of the gentlemen and farmers ... took upon them to destroy the ant-hills.” However, while landlords were prepared to offer farmers considerable financial incentive to remove their anthills, the farming communities remained strongly resistant to change. [Young \(1771a, 55\)](#) notes of meadows near Haselbech (Northamptonshire) that:

“The ant-hills are in amazing numbers, and these boobies [fools] insist very gravely, that they are an advantage to the fields, by varying the bite of the cattle; and yielding a food nearly as valuable as the rest of the close. There are opinions so truly absurd, that to attempt a refutation in form, would be preposterous.”

Despite farmers’ insistence that there were advantages to maintaining anthills on the meadows, it appears that the improvers were so opposed to the practice – for example, [Young \(1771a, 20\)](#) notes of the area around Buckingham “In no part of the kingdom have I met with husbandry that requires greater amendment than this” – that they did not consider it to be of any merit (unlike the practice of fogging that [Young, 1796](#), applied to his farm). As a result we found no detailed description of the practice or local knowledge in the literature, but instead mention is invariably accompanied by information on how best to remove the ant-hills and the benefits that would follow. Yet its widespread nature and the extent to which farmers held onto their beliefs despite efforts to dissuade them suggests that this was a genuine traditional management system with its own culture and knowledge base. Were it to still exist, we suspect there would be strong ecological reasons for preserving it because of the contribution ant mounds make to species diversity in meadows by favouring plant species that cannot compete with the more luxuriant vegetation between the mounds ([King, 1981](#); [Dean et al., 1997](#)) as well as encouraging a diverse fauna ([National Trust](#), undated).

5.2.3. Management of “open-field”, “common” or “Lammas” meadows

Another “traditional” system of field management heavily criticised by the improvers was “open field”, “common” or “Lammas” meadow management – generally located along river banks and described by [Sinclair \(1832\)](#) as one of the four types of “natural hay meadows”. [Donaldson \(1796, v2\)](#) contends “open field meadows” were managed very differently as a result of a tenure system where the meadows were under private management for part of the year, but at a set time after harvest, became common property for grazing.¹⁶ He notes:

“These open-field meadows are never manured; the whole horses, cattle and sheep in the parish, are allowed to range over them uncontrolled, from the close of hay-harvest till the end of March, or the beginning of April: And, while the mode of improving the quality and quantity of grass, by means of irrigation, is entirely neglected; there are very few instances, where any degree of attention is bestowed to prevent the lands from being overflowed at improper seasons.”

In the first Oxfordshire report, [Davis \(1794\)](#) suggests that the lack of a fixed time to “turn in the cattle” meant that the owners of the hay left it standing as long as possible in order to add weight before they handed it over for open grazing (although he notes that consequently the quality suffered). The fact that the hay crop is owned by one person and the aftermath another/others was widely blamed for these lands being neglected in terms of drainage, manuring and flood protection (e.g. [Billingsly, 1795](#); [Donaldson, 1796](#); [Middleton, 1813](#)) with the inability to improve the meadows reportedly reducing the farmer to “the drone who follows the practice of his forefathers” ([Mavor, 1813](#)–w.r.t. meadows along the Thames). Interestingly, [Marshall \(1789, 199\)](#) also blames the late-cutting of common meadows managed under this tenure system for establishing a tradition of “suffer(ing) grass to stand much to long” even after this management system had been abandoned.

A particular form of open-field meadow management is “Lammas tenure.” In this case, rather than ownership changing once the hay crop has been taken, dates for the meadow transfer are fixed to occur during the Anglo-Saxon holiday of Lammas (between the 1st August and 1st September). For example, [Foot \(1794\)](#) observes that meadow land along the river Lea in Middlesex was managed in this fashion and, in this case, meadows were laid up to be used for hay on the 5th of April and opened up for common usage again on the 12th of August after the hay has been made and secured. Although there is now little mention of Lammas meadows, the literature suggests that as well as London ([Foot, 1794](#)), it also existed around Coventry ([Harries, 1789](#)) and Nottinghamshire near towns along the river Trent ([Lowe, 1794](#)).

Whether this constitutes a distinct form of meadow management with its own TEK is again unverifiable from the literature alone, however, it must be remembered that [Sinclair \(1832\)](#) described these meadows as one of the four types of “natural hay meadows” while [Marshall’s \(1789\)](#) observation that the tradition of late cutting carried on after the management system was changed (via enclosure) indicates behaviours associated with open field management had become culturally embedded. We could find little historical record of the vegetation on these meadows – perhaps because of the lack of agricultural value ascribed to them. Some ascertained it was “worthless” ([Middleton, 1813](#)) or “scanty” ([Donaldson, 1796](#)) and that flooding caused a succession of “aquatic plants of inferior value” ([Davis, 1794](#)). This may have been the case from an agricultural perspective, however, these meadows could have been of significant ecological value as a result of the late cutting and lack of intensive management. In a report on the Isle of Alney in Gloucestershire (periodically flooded meadows held as common land in the middle ages – [Herbert, 1988](#)) [Marshall \(1789\)](#) produced a detailed species list consisting of 91 plant species in order of frequency of occurrence – suggesting that, at least in this case, the biodiversity of such meadow management systems was high. Today Alney Island is a nature reserve.

6. Conclusions

This paper has considered the potential of online historical agricultural texts to contribute to our understanding of TEK and, in the process, added to the broader critical reflection on the nature and application of TEK. The key advantage of digitised historical sources is their accessibility. Comprehensive coverage of the most relevant texts, free access from any computer connected to the internet, and the ability to search documents for key words or phrases mean that accessing

¹⁶ In a more recent account of Lammas meadows, [Brian \(1993, p.57\)](#) notes that “In comparison with the extent of the other three elements of the medieval open field system still surviving, i.e. arable land still visible as ridge and furrow fossilised under pasture, ancient woodlands and manorial waste (now statutory common land), the acreage of the surviving common meadows is minute”.

centuries old agricultural texts for relevant information has become as easy as accessing contemporary literature. Ecologists; rural geographers; landscape researchers and all others with an interest in traditional agricultural knowledge and practices can access these sources at will; potentially complementing and/or validating any study of traditional land management. For TEK studies in particular; we believe this will help address concerns for the unreliability of oral sources (e.g. [Huntington, 2000](#); [Bart, 2010](#)) and contribute to improving research; resource management and managing environmental change ([Huntington, 2000](#)).

In the process of analysis a number of issues emerged concerning the relationship between literature-based TEK and oral studies of TEK. One issue concerns the local origins of TEK in Europe. In the study, we conclude that the TEK reported in European research could have been influenced by the written literature rather than being solely the result of a long relationship between people and their environment. Reference to practices now deemed “TEK” in the historical literature, the extent to which the historical literature was pan-European, and the efforts made from the middle of the 18th Century to promote agriculture amongst peasant communities all suggest that written and scientific reports of agricultural practices could have spread throughout the continent – even to remote communities. While the coverage of traditional agricultural practices in the literature is sporadic (also observed by [Grigg, 1967](#)), there is such a vast array of knowledge contained in the historical English literature alone that the likelihood of TEK being truly “unique” to any region within Europe is, in our judgement, exceptionally low. We know from contemporary studies that knowledge flows freely between ‘written and oral’ and ‘scientific and traditional’ accounts ([Frazão-Moreira et al., 2009](#); [Leonti, 2011](#)), so why should communities in the past have been any different?

This does not, in any sense, mean that gathering TEK from oral accounts is invalid. While the literature describes practices that can be observed throughout Europe, the sporadic coverage means that although detailed descriptions of practices exist, we often do not know where they were applied, why they were applied, or what other practices they were associated with. Besides, given the biases of the authors, reports of TEK in the literature are not necessarily accurate and need to be regarded with some caution. Only on rare occasions does the literature provide sufficient information to enable the TEK (knowledge, practices and beliefs) to be reassembled. In the case of hay meadow management, the practice of “fogging” was the only traditional practice that possibly fell into this category ([Davies, 1815](#)). While communities are still following traditional practices it is thus essential to undertake conventional TEK studies, with historical publications being used to validate and ‘fill in the gaps’ of knowledge where possible – thus assisting in cases where TEK exists more in memory than practice ([Benz et al., 2000](#)), where TEK is fragmented ([Ziembicki et al., 2013](#)), or where information gleaned is inconsistent ([Bart, 2010](#); [Don, 2010](#)).

On the other hand, historical sources do provide something that conventional TEK studies do not – an understanding of traditional agriculture that is not limited to small communities living in remote locations. In regions of intensive land management there are many isolated areas (protected meadows, etc.) of high ecological importance that are no longer associated with their communities of practice. For example, in Buckinghamshire it is still possible to find species rich meadows dominated by anthills such as Coombe Hill¹⁷ ([National Trust](#), undated), now managed as a nature reserve. Recent criticisms that TEK has been miss-appropriated and decontextualized ([Armstrong et al., 2017](#)) may also extend to the way it valorises existing marginal agricultural practices (no matter how thin the evidence is), but is entirely unable to contribute to the preservation of other vestiges of traditional

agriculture. However, by investigating the practices that agricultural innovators regarded as regressive and poor farming – such as anthill and open field hay meadow management – forms of TEK can be located and acknowledged as culturally and historically important on a national level (rather than written out or ignored).

Another reason literature-based TEK cannot replace oral TEK is because of the adaptive nature of TEK. The concept of TEK is problematic in that it is reportedly in a process of constant adaptation to social and environmental conditions ([Davis and Ruddle, 2010](#)) yet, simultaneously, the management systems that result are important because they have “been developed and refined over generations of environmental change” ([Glaserapp and von Thornton, 2011, 770](#)). The paradox here is that the gathering of TEK at any point in the process of its development and implementation in policy (without some form of genuine adaptive management) effectively freezes TEK development – the very process that is responsible for its reported utility in environmental management. Further, if this is true, then the longer we look back (whether oral or literature based studies), the less adapted the systems will be to the current social, economic and environmental context – meaning centuries old literature is very unlikely to be adapted to the contemporary social, economic and environmental conditions. In this case, its main utility will be to support remaining traditional management systems as the context that created the TEK originally cannot be recreated by any other means than adaptive management by local communities. However, it may also help us understand and manage isolated areas of ecological importance.

The objective of this paper to illustrate the potential utility of freely available on-line literature means that we barely scratched the surface of the “TEK” related to hay meadows that might be available – let alone knowledge on livestock management, field cropping systems, fruit production, veterinary care, and many other topics, which are referred to abundantly in such sources. Further, the similarities of traditional practices across Europe suggests that explorations of wider European pre-industrial literature (see [Von Münchhausen, 1766](#); [Loudon, 1839](#)) may reveal more about traditional hay meadow management practices in Europe as well as other topics of interest. We do not contend that it will be possible to use TEK to “reconstruct” entire systems of management from the literature alone. However, we believe its easy accessibility means it can be of considerable assistance to researchers seeking to either validate or fill in knowledge gaps concerning traditional management systems, for example, by exploring traditional means of storing hay, moss control, manuring of meadows, and so on – issues for which there is a considerable volume of information but that we have only briefly touched upon in this study. We hope that our analysis of what is, in reality, only a small proportion of the total information available, encourages and assists others to utilise this source for understanding traditional management systems across Europe.

Acknowledgements

This project was funded as part of the Norwegian Research Council’s ENKALL project (230278). We would like to thank the anonymous reviewers for the careful consideration of the paper and their insightful suggestions. Thanks also to Google and all those involved in making these invaluable sources accessible to all.

References

- [A Country Gentleman, 1755. A New System of Agriculture. A. Millar, London \(208 Pages\).](#)
- [Allen, R.C., 1999. Tracking the agricultural revolution in England. *Econ. Hist. Rev.* 52 \(2\), 209–235.](#)
- [Anon, 1765. Observations on the importance of agriculture to Great Britain; and the means of promoting the improvement of it at present, in a letter to the editors. *Mus. Rusticum* 5 \(26\), 241–249.](#)
- [Anon, 1803. Critical catalogue. *Agric. Mag.* 8, 138–144.](#)
- [Anon, 1855. Spring food for livestock. *Farmer’s Mag.* 7 \(June\), 507–508.](#)
- [Armstrong, C.G., Shoemaker, A.C., McKechnie, I., Ekblom, A., Szabó, P., Lane, P.J., McAlvay, A.C., Boles, O.J., Walshaw, S., Petek, N., 2017. Anthropological](#)

¹⁷ Also see Kingcup Meadows and Oldhouse Wood (<https://necmsi.esdm.co.uk/PDFsForWeb/Citation/1006013.pdf>) and Pilch Fields (<https://necmsi.esdm.co.uk/PDFsForWeb/Citation/1001543.pdf>)

- contributions to historical ecology: 50 questions, infinite prospects. *PLoS One* 12, e0171883.
- Babai, D., Molnár, Z., 2014. Small-scale traditional management of highly species-rich grasslands in the Carpathians. *Agric. Ecosyst. Environ.* 182, 123–130.
- Babai, D., Tóth, A., Szentirmai, I., Biró, M., Máté, A., Demeter, L., Szépligeti, M., Varga, A., Molnár, Á., Kun, R., 2015. Do conservation and agri-environmental regulations effectively support traditional small-scale farming in East-Central European cultural landscapes? *Biodivers. Conserv.* 24, 3305.
- Baily, J., Cully, G., 1813. *General View of the Agriculture of the County of Northumberland*. Sherwood, Neely and Jones, London (361 pages).
- Bart, D., Simon, M., 2013. Evaluating local knowledge to develop integrative invasive-species control strategies. *Hum. Ecol.* 41, 779–788.
- Bart, D., 2010. Using weed control knowledge from declining agricultural communities in invasive-species management. *Hum. Ecol.* 38, 77–785.
- Barthel, S., Crumley, C., Svedin, U., 2013. Biocultural refugia: combating the erosion of diversity in landscapes of food production. *Ecol. Soc.* 18 (4), 71.
- Baxter, W., 1839. *British Phænogamous Botany*. Baxter, Oxford (337 Pages).
- Benton, T.G., Vickery, J.A., Wilson, J.D., 2003. Farmland biodiversity: is habitat heterogeneity the key? *Trends Ecol. Evol.* 18, 182–188.
- Benz, B.F., Cevallos, J., Santana, F., Rosales, J., Graf, S., 2000. Losing knowledge about plant use in the Sierra de Manantlan biosphere reserve, Mexico. *Econ. Bot.* 54, 183–191.
- Berkes, F., Colding, J., Folke, C., 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecol. Appl.* 10, 1251–1262.
- Berkes, F., 2012. *Sacred Ecology*. Routledge, London.
- Best, H., 1641. *Rural Economy in Yorkshire in 1641*. Republished and Edited by C.B. Robinson (1857). Whittaker & Co., London 187 Pages. (archive.org).
- Billingsly, J., 1795. *General View of the Agriculture of the County of Somerset*. R. Cruttwell, Bath (320 Pages).
- Biró, É., Babai, D., Bódis, J., Molnár, Z., 2014. Lack of knowledge or loss of knowledge? Traditional ecological knowledge of population dynamics of threatened plant species in East-Central Europe. *J. Nat. Conserv.* 22, 318–325.
- Boafo, Y.A., Saito, O., Kato, S., Kamiyama, C., Takeuchi, K., Nakahara, M., 2015. The role of traditional ecological knowledge in ecosystem services management: the case of four rural communities in Northern Ghana. *International Journal of Biodiversity Science. Ecosyst. Serv. Manage.* 12, 24–38.
- Boys, J., 1794. Account of romney marsh. *Ann. Agric.* 22, 388–400.
- Boys, J., 1796. *General View of the Agriculture of the County of Kent*. G. Nichol, London (206 Pages).
- Brassley, P., 1996. Silage in Britain, 1880–1990: The delayed adoption of an innovation. *Agric. Hist. Rev.* 44, 63–87.
- Brian, A., 1993. Lamas meadows. *Landscape Hist.* 15 (1), 57–69.
- Brown, R., 1799. *General View of the Agriculture of the West Riding of Yorkshire*. James Watson, Edinburgh (121 Pages).
- Bullock, J.M., Jefferson, R.G., Blackstock, T.H., Pakeman, R.J., Emmett, B.A., Pywell, R.J., Grime, J.P., Silvertown, J., 2011. Semi-natural Grasslands. UNEP–WCMC, Cambridge, UK (In: Technical Report: The UK National Ecosystem Assessment, pp 162–195).
- Burke, J.F., 1834. *British Husbandry*, vol. 1 Baldwin and Cradock, London (534 Pages).
- Chalmers, A., 1814. a new edition. *The General Biographical Dictionary*, vol. 17 Nichols and Son, London (524 Pages).
- Cook, H., Williamson, T., 2007. *Water Meadows: History, Ecology and Conservation*. Windgather Press.
- Critchley, C.N.R., Fowbert, J.A., Wright, B., 2007. Dynamics of species-rich upland hay meadows over 15 years and their relation with agricultural management practices. *Appl. Veg. Sci.* 10, 307–314.
- Curtis, W., 1789. General observations on the advantage which may result from the introduction of the seeds of our best grasses. *Ann. Agric.* 12, 343–361.
- Curtis, W., 1812. *Practical Observations on the British Grasses Especially Such as are Best Adapted to the Laying Down or Improving of Meadows and Pastures Likewise by the Enumeration of the British Grasses*. H.D. Symonds, London (116 Pages).
- Dahlström, A., Lennartsson, T., Wissman, J., 2008. Biodiversity and traditional land use in South-Central Sweden: the significance of management timing. *Environ. Hist.* 14, 385–403.
- Dahlström, A., Iuga, A.-M., Lennartsson, T., 2013. Managing biodiversity rich hay meadows in the EU: a comparison of Swedish and Romanian grasslands. *Environ. Conserv.* 40, 194–205.
- Daniels, S., Watkins, C., 1991. Picturesque landscaping and estate management: uvedale price at foxley, 1770–1829. *Rural Hist.* 2, 141–169.
- Davies, W., 1815. *General View of the Agriculture and Domestic Economy of South Wales*, vol. 1 B. McMillan, London (613 Pages).
- Davies, W., 1948. *Foggage*. *Agric. LV* 93–97.
- Davis, A., Ruddle, K., 2010. Constructing confidence: rational skepticism and systematic enquiry in local ecological knowledge research. *Ecol. Appl.* 20, 880–894.
- Davis, R., 1794. *General View of the Agriculture of the County of Oxford*. Bulmer & Co., London (39 Pages).
- Dean, W.R.J., Milton, S.J., Klotz, S., 1997. The role of ant nest-mounds in maintaining small-scale patchiness in dry grasslands in Central Germany. *Biodivers. Conserv.* 6, 1293–1307.
- Dickson, R.W., 1807. new edition. *Practical Agriculture; or A Complete System of Modern Husbandry*, vol. 2 Richard Phillips, London (767 Pages).
- Don, W., 2010. The titi project, traditional ecological knowledge and science: a critique. *J. R. Soc. N. Z.* 40, 39–43.
- Donaldson, J.D., 1796. *Modern Agriculture*, vol. 2 Adam Neill & Co., Edinburgh (428 Pages).
- Donaldson, J., 1854. *Agricultural Biography: Containing a Notice of the Life and Writings of the British Authors on Agriculture from the Earliest Date in 1480 to the Present Time*. Printer Unkown, London (137 Pages).
- Dove, M.R., 2002. Hybrid histories and indigenous knowledge among Asian rubber small holders. *Int. Soc. Sci. J.* 54, 349–359.
- Drew, J.A., 2005. Use of traditional ecological knowledge in marine conservation. *Conserv. Biol.* 19, 1286–1293.
- Du Monceau, M.D., 1759. *A Practical Treatise of Husbandry*. J. Whiston & B. White, London 491 pages (archive.org).
- Du Monceau, M.D., 1762. *Elements D'Agriculture*. H.L. Guerin & L.F. Delatour, Paris (499 Pages).
- Eagleton, T., 1986. *Against the Grain Essays, 1975/1985-*. Verso, London.
- Edwards, A.R., Mortimer, S.R., Lawson, C.S., Westbury, D.B., Harris, S.J., Woodcock, B.A., Brown, V.K., 2007. Hay strewing, brush harvesting of seed and soil disturbance as tools for the enhancement of botanical diversity in grasslands. *Biol. Conserv.* 134, 372–382.
- Ellen, R., Harris, H., 2000. Introduction. In: Ellen, R., Parkes, P., Bicker, A. (Eds.), *Indigenous Environmental Knowledge and Its Transformations: Critical Anthropological Perspectives*. Harwood academic publishers, Netherlands p 1–35.
- Ellis, W., 1743. *The Modern Husbandman, Or, the Practice of Farming*. T. Osborne, London (152 Pages).
- Ellis, W., 1744a. *The Modern Husbandman, Or, the Practice of Farming*, vol. 3 T. Osborne, London (142 Pages).
- Ellis, W., 1744b. *The Modern Husbandman, Or, the Practice of Farming*, vol. 4 T. Osborne, London (150 Pages).
- Ellis, W., 1746. *Agriculture Improved: or the Practice of Husbandry Displayed*. T. Osborne, London.
- Ellis, W., 1750a. *Ellis's Husbandry, Abridged and Methodised*, vol. 1 W. Nicholl and G. Robinson, London (517 Pages).
- Ellis, W., 1750b. *The Modern Husbandman*, vol. 8 D. Brown, London (400 Pages).
- Eriksson, O., Bolmgren, K., Westin, A., Lennartsson, T., 2015. Historic hay cutting dates from Sweden 1873–1951 and their implications for conservation management of species-rich meadows. *Biol. Conserv.* 184, 100–107.
- Evans, J., 1804. *Letters Written During a Tour of South Wales in the Year 1803 and at Other Times*. C. & R. Baldwin, London (449 Pages).
- Fazey, I., Fazey, J.A., Salisbury, J.G., Lindenmayer, D.B., Dovers, S., 2006. The nature and role of experiential knowledge for environmental conservation. *Environ. Conserv.* 33, 1–10.
- Fernández-Giménez, M.E., Fillat Estaque, F., 2012. Pyrenean pastoralists' ecological knowledge: documentation and application to natural resource management and adaptation. *Hum. Ecol.* 40, 287–300.
- Fernández-Llamazares, Á., Díaz-Reviriego, I., Luz, A.C., Cabeza, M., Pyhälä, A., Reyes-García, V., 2015. Rapid ecosystem change challenges the adaptive capacity of local environmental knowledge. *Global Environ. Change* 31, 272–284.
- Fitzherbert, 1534. *The Book of Husbandry*. Reprinted from the 1534 Edition and Edited by W.W. Skeat (1882). Truebner & Co., London 167 Pages. (archive.org) (1534).
- Foot, P., 1794. *General View of the Agriculture of the County of Middlesex*. John Nichols, London (90 Pages).
- Frazão-Moreira, A., Carvalho, A.M., Martins, M.E., 2009. Local ecological knowledge also comes from books: cultural change, landscape transformation and conservation of biodiversity in two protected areas in Portugal. *Anthropol. Notebooks* 15, 27–36.
- Gómez-Baggethun, E., Mingorria, S., Reyes-García, V., Calvet, L., Montes, C., 2010. Traditional ecological knowledge trends in the transition to a market economy: empirical study in the doñana natural areas. *Conserv. Biol.* 24, 721–729.
- Gómez-Baggethun, E., Corbera, E., Reyes-García, V., 2013. Traditional ecological knowledge and global environmental change: research findings and policy implications. *Ecol. Soc.* 18.
- Gadgil, M., Olsson, P., Berkes, F., Folke, C., 2003. Exploring the role of local ecological knowledge in ecosystem management: three case studies. In: Berkes, F., Colding, J., Folke, C. (Eds.), *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, Cambridge (Pages 189–209).
- Glaserapp, M., von Thornton, T.F., 2011. Traditional ecological knowledge of swiss alpine farmers and their resilience to socioecological change. *Hum. Ecol.* 39, 769–781.
- Goddard, N., 1983. The development and influence of agricultural periodicals and newspapers, 1780–1880. *Agric. Hist. Rev.* 31, 116–131.
- Grigg, D.B., 1967. The changing agricultural geography of England: a commentary on the sources available for the reconstruction of the agricultural geography of England, 1770–1850. *Trans. Inst. Br. Geogr.* 41, 73–96.
- Høeg, O.A., 1974. *Planter Og Tradisjon. Floraen I Levende Tale Og Tradisjon I Norge 1925–1973 (Plants and Tradition: Flora in the Living Tales and Traditions of Norway)*. Universitetsforlaget, Oslo.
- Hale, T., 1758. second edition. *A Compleat Body of Husbandry*, vol. 1 T. Osborne, London (402 Pages).
- Hall, A.D., 1914. *A Pilgrimage of British Farming 1910–1912*. John Murray, London 452 Pages. (archive.org).
- Halstead, P., 1998. Ask the fellows who lop the hay: leaf-fodder in the mountains of northwest Greece. *Rural Hist.* 9, 211–234.
- Harries, E., 1789. *Farming Minutes: made during a short tour in 1788*. *Ann. Agric.* 11, 8–12.
- Hassal, C., 1794. *General View of the Agriculture of the County of Pembroke*. J. Smeeton, London (63 Pages).
- Henry (nom de plume –A Practical Farmer), D., 1771. *The Complete English Farmer*. F. Newbery, London (432 Pages).
- Herbert, N.M. (Ed.), 1988. 'Medieval Gloucester: Topography', in *A History of the County of Gloucester: Volume 4, the City of Gloucester*. *British History Online*, London, 1988, pp. 63–72. <http://www.british-history.ac.uk/vch/glos/vol4/pp63-72>. (Accessed 22 July 2017).

- Hernández-Morcillo, M., Hoberg, J., Oteros-Rozas, E., Plieninger, T., Gómez-Baggethun, E., Reyes-García, V., 2014. Traditional ecological knowledge in Europe: status quo and insights for the environmental policy agenda. *Environ. Sci. Policy Sustainable Dev.* 56, 3–17.
- Horne (nom de plume – A Lincolnshire Grazier), T.H., 1830. *The Complete Grazier*, fifth edition. B. Crosby and Co., London (655 Pages).
- Howden, S.M., Soussana, J.-F., Tubiello, F.N., Chhetri, N., Dunlop, M., Meinke, H., 2007. Adapting agriculture to climate change. *Proc. Natl. Acad. Sci.* 104, 19691–19696.
- Huntington, H.P., 2000. Using traditional ecological knowledge in science: methods and applications. *Ecol. Appl.* 10, 1270–1274.
- James, W., Malcolm, J., 1794. *General View of the Agriculture of the County of Buckingham*. Colin Macrae, London (63 Pages).
- James, R., 2010. An assessment of the legibility of Google Books. *J. Access Serv.* 7, 223–228.
- Jefferson, R.G., 2005. The conservation management of upland hay meadows in Britain: a review. *Grass Forage Sci.* 60, 322–331.
- John, H., Dullau, S., Baasch, A., Tischev, S., 2016. Re-introduction of target species into degraded lowland haymeadows: how to manage the crucial first year? *Ecol. Eng.* 86, 223–230.
- Kerr, R., 1809. *General View of the Agriculture of the County of Berwick*. Richard Phillips, London (503 Pages).
- King, T., 1981. Ant-hills and grassland history. *J. Biogeogr.* 329–334.
- Kirkham, F.W., Tallowin, J.R.B., Sanderson, R.A., Bhogal, A., Chambers, B.J., Stevens, D.P., 2008. The impact of organic and inorganic fertilizers and lime on the species richness and plant functional characteristics of hay meadow communities. *Biol. Conserv.* 141, 1411–1427.
- Kizos, T., Plieninger, T., Schaich, H., 2013. Instead of 40 sheep there are 400: traditional grazing practices and landscape change in western Lesvos, Greece. *Landscape Res.* 38, 476–498.
- Kowalsky, N., 2014. Between relativism and romanticism traditional ecological knowledge as social critique. In: Sepsi, N., Nagy, J., Vassányi, M., Kenyeres, J. (Eds.), *Indigenous Perspectives of North America: A Collection of Studies*. Cambridge Scholars, Newcastle, pp. 2–31.
- Krause, B., Culmsee, H., Wesche, K., Bergmeier, E., Leuschner, C., 2011. Habitat loss of floodplain meadows in north Germany since the 1950. *Biodivers. Conserv.* 20, 2347–2364.
- Laurence, E., 1727. *The Duty of a Steward to His Lord*. John Shuckburgh, London (212 Pages).
- Leonti, M., 2011. The future is written: impact of scripts on the cognition, selection, knowledge and transmission of medicinal plant use and its implications for ethnobotany and ethnopharmacology. *J. Ethnopharmacol.* 134, 542–555.
- Lisle, E., 1757. *Observations in Husbandry*. J. Hughs, London 450 pages. (archive.org).
- Lloyd, T., Turnor, 1794. *General View of the Agriculture of the County of Cardigan*. W. Smith, London (37 Pages).
- Loudon, J., 1839. *An Encyclopedia of Agriculture*, 4th ed. Longman, Orme, Brown, Green and Longmans, London.
- Lowe, P., Murdoch, J., Marsden, T., Munton, R., Flynn, A., 1993. Regulating the new rural spaces: the uneven development of land. *J. Rural Stud.* 9, 205–222.
- Lowe, A., 1794. *General View of the Agriculture of the County of Berwick*. B. Millan, London (136 Pages).
- Marsden, T., Murdoch, J., Lowe, P., Munton, R., Flynn, A., 1993. *Constructing the Countryside*. UCL Press, London.
- Marshall, W., 1789. *The Rural Economy of Gloucestershire*, vol. 1 R. Raikes, London 332 pages. (hathitrust.org).
- Matulionyte, R., 2016. 10 years for Google Books and Europeana: copyright law lessons that the EU could learn from the USA. *Int. J. Law Inf. Technol.* 24, 44–71.
- Mavor, W., 1812. *Five Hundred Pointes of Good Husbandry Together with a Book of Huswifery* by Thomas Tusser. Lackington, Allen & Co., London (337 Pages).
- Mavor, W., 1813. *General View of the Agriculture of the County of Berkshire*. Sherwood, Neely & Jones, London (548 Pages).
- McMillen, H., Ticktin, T., Springer, H.K., 2017. The future is behind us: traditional ecological knowledge and resilience over time on Hawai'i Island. *Reg. Environ. Change* 17, 579–592.
- Middleton, J., 1798. *View of the Agriculture of Middlesex*. B. Macmillan, London (597 Pages).
- Middleton, J., 1813. *General View of the Agriculture of Middlesex*. Sherwood, Neely & Jones, London (682 Pages).
- Mortimer, J., 1708. *The Whole Art of Husbandry; or The Way of Managing and Improving Land*, second edition. H. Mortlock, London (632 pages).
- National Trust, Undated. Discover the Amazing Anthills at Coombe Hill.** <https://www.nationaltrust.org.uk/chilterns-countryside/features/discover-the-amazing-anthills-at-coombe-hill>. (Accessed 12th October, 2017).
- Norderhaug, A., Ihse, M., Pedersen, O., 2000. Biotope patterns and abundance of meadow plant species in a Norwegian rural landscape. *Landscape Ecol.* 15, 201–218.
- Overton, M., 1996. Re-establishing the English agricultural revolution. *Agric. Hist. Rev.* 44 (1), 1–20.
- Payne, W., Herrtage, S., 1878. *Five Hundred Pointes of Good Husbandry* by Thomas Tusser. Turner and Co., London, pp. 1878 (archive.org).
- Pearce, T., Ford, J., Willox, A.C., Smit, B., 2015. Inuit traditional ecological knowledge (TEK), subsistence hunting and adaptation to climate change in the Canadian Arctic. *Arctic* 233–245.
- Peterken, G.F., 2013. *Meadows*. British Wildlife Publishing.
- Petit, S., Watkins, C., 2003. Pollarding Trees: changing attitudes to a traditional land management practice in Britain. *Rural Hist.* 14, 157–176.
- Philo-Gramen, 1765. On the separate culture of grasses, and the improvement of grass lands. *Mus. Rusticum* 5 (34), 161–173.
- Priest, J., 1810. *General view of the Agriculture of Buckinghamshire*. Richard Phillips, London (412 Pages).
- Rackham, O., 1986. *The History of the Countryside*. J.M. Dent, London.
- Read, C.S., 1849. On the farming of south Wales. *J. R. Agric. Soc. Engl.* 10, 122–165.
- Rennie, G., Broun, R., Shirreff, J., 1794. *General View of the Agriculture of the West Riding of Yorkshire*. W. Bulmer & Son, London (140 Pages).
- Reo, N.J., 2011. The importance of belief systems in traditional ecological knowledge initiatives. *Int. Indigenous Policy J.* 2. <http://dx.doi.org/10.18584/iipj.2011.2.4.8>.
- Rham, W.L., 1845. *Dictionary of the Farm*, second edition. Charles Knight & Co., London (576 Pages).
- Ridding, L.E., Redhead, J.W., Pywell, R.F., 2015. Fate of semi-natural grassland in England between 1960 and 2013: a test of national conservation policy. *Glob. Ecol. Conserv.* 4, 516–525.
- Riley, M., 2005. Silent meadows: the uncertain decline and conservation of hay meadows in the British landscape. *Landscape Res.* 30, 437–458.
- Riley, M., 2006. Silage for Self-sufficiency? – The wartime promotion of silage and its use in the Peak District. *Agric. Hist. Rev.* 77–88.
- Riley, M., 2008. Experts in their fields: farmer-expert knowledges and environmentally friendly farming practices. *Environ. Plan. A* 40, 1277–1293.
- Riseth, J.A., 2007. An indigenous perspective on national parks and Sámi reindeer management in Norway. *Geogr. Res.* 45, 177–185.
- Rouquette, J.R., Posthumus, H., Gowing, D.J.G., Tucker, G., Dawson, Q.L., Hess, T.M., Morris, J., 2009. Valuing nature-conservation interests on agricultural floodplains. *J. Appl. Ecol.* 46, 289–296.
- Ruddle, K., 1994. *Local Knowledge in the Folk Management of Fisheries and Coastal Marine Environments*. Folk Management in the World's Fisheries: Lessons for Modern Fisheries Management. University Press of Colorado, Boulder, pp. 161–206.
- Rudge, T., 1807. *General View of the Agriculture of the County of Gloucester*. Richard Phillips, London (408 Pages).
- Selvi, F., Valleri, M., 2012. Cork oak woodlands in the north Tyrrhenian area (Italy): distribution and plant species diversity of a relict forest ecosystem. *Biodivers. Conserv.* 21, 3061–3078.
- Shucksmith, M., 2017. Re-imagining the rural: from rural idyll to Good Countryside. *J. Rural Stud.* <http://dx.doi.org/10.1016/j.jrurstud.2016.07.019>.
- Sinclair, J., 1797. John Sinclair's address to the board of agriculture. *Ann. Agric.* 29, 349–365.
- Sinclair, J., 1801. Hints as to the advantages of old pastures, and on the conversion of grass lands into tillage. *Farmer's Mag.* 2, 252–261.
- Sinclair, J., 1802. *Essays on Miscellaneous Subjects*. A. Strahan, London (466 Pages).
- Sinclair, J., 1832. *The Code of Agriculture*, fifth edition. Sherwood, Gilbert & Piper, London (520 Pages).
- Smith, R.S., Jones, L., 1991. The phenology of mesotrophic grassland in the pennine dales, Northern England: historic hay cutting dates, vegetation variation and plant species phenologies. *J. Appl. Ecol.* 28 (1), 42–59.
- Somerville, P., Smith, R., McElwee, G., 2015. The dark side of the rural idyll: stories of illegal/illicit economic activity in the UK countryside. *J. Rural Stud.* 39, 219–228.
- Somerville, J., 1800. *The System Followed During the Last Two Years by the Board of Agriculture*, second edition. W. Miller, London (300 Pages).
- Stephens, H., Norton, J.P., 1851. *The Farmer's Guide to Scientific and Practical Agriculture*, vol. 2 Leonard Scott & Co, New York (782 Pages).
- Török, P., Helm, A., 2017. Ecological theory provides strong support for habitat restoration. *Biol. Conserv.* 206, 85–91.
- Tibby, J., Lane, M.B., Gell, P.A., 2007. Local knowledge and environmental management: a cautionary tale from Lake Ainsworth, New South Wales, Australia. *Environ. Conserv.* 34 (4), 334–341.
- Tobin, W., 2008. Full-text search capability: a new tool for researching the development of scientific language. The 'Whirlpool nebula' as a case study. *Notes Rec. R. Soc.* 62, 187–196.
- Tress, G., Tress, B., Fry, G., 2006. Publishing integrative landscape research: analysis of editorial policies of peer-reviewed journals. *Environ. Sci. Policy* 9, 466–475.
- Tunón, H., Kvarnström, M.P.M., 2015. Report from the Project: Indigenous and Local Knowledge in a Scoping Study for a Nordic IPBES Assessment. Swedish Biodiversity Centre, Uppsala Available online at: <https://www.cbd.int/doc/meetings/sbi/sbi-01/other/sbi-01-nordicilk-ipbes-2015-en.pdf>.
- United Nations, 1992. *Convention on Biological Diversity*. United Nations, Rio de Janeiro.
- Vancouver, C., 1810. *General View of the Agriculture of Hampshire Including the Isle of Wight*. Richard Phillips, London (520 Pages).
- Verral, H., 1799. On the use and misuse of lime with some observations and animadversions on other parts of farming. *Ann. Agric.* 32, 99–136.
- Von Münchhausen, O., 1766. *Des Hausvaters Botanische, Physikalische und Oeconomische Bibliothek (The House Father's Botanical, Physical and Economic Library)*. Zehnter Teil. R. Foersters & J. Erben, Hannover (367 Pages).
- Wade-Martins, S., Williamson, T., 1994. Floated water-meadows in Norfolk: a misplaced innovation. *Agric. Hist. Rev.* 20–37.
- Watkins, C., 2014. *Trees, Woods and Forests: A Social and Cultural History*. Reaktion Books.
- Weston, R., 1773. *Tracts on Practical Agriculture and Gardening*. S. Hooper, London (297 pages).
- Wilson, G.A., Burton, R.J.F., 2015. 'Neo-productivist' agriculture: spatio-temporal versus structuralist perspectives. *J. Rural Stud.* 38, 52–64.
- Worldidge, J., 1681. *Systema Agriculture: Being the Mystery of Husbandry Discovered and Laid Open*. T. Dring, London (324 Pages).
- Young, A., 1769. *A Six Weeks Tour Through the Southern Counties of England and Wales*. Strahan & Nicoll, London (377 pages).
- Young, A., 1771a. *The Farmer's Tour Through the East of England*, vol.1 Strahan & Nicoll, London (495 pages).

- Young, A., 1771b. 2nd edition. A Six Month's Tour Through the North of England, vol. 4 Strahan & Nicoll, London 466 pages (archive.org).
- Young, A., 1778. How far is agriculture capable of being made one of the pursuits, in which men of a certain rank may educate their children, as at present in commerce and manufactures? Written, 1778. Ann. Agric. 21 (1793), 229–279.
- Young, A., 1793. Substance of Sir John Sinclair's Speech in Parliament on the 15th of May, 1793, when be proposed the Establishment of a Board of Agriculture. Ann. Agric. 21, 129–150.
- Young, A., 1796. Experiments on some grasses. Ann. Agric. 27, 372–408.
- Young, A., 1804a. General View of the Agriculture of Hertfordshire. McMillan, London (236 Pages).
- Young, A., 1804b. The Farmer's Calendar, new edition. Richard Phillips, London 604 Pages. (archive.org).
- Ziembicki, M., Woinarski, J., Mackey, B., 2013. Evaluating the status of species using Indigenous knowledge: novel evidence for major native mammal declines in northern Australia. Biol. Conserv. 157, 78–92.