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Psychological morbidity in the farming community: a literature review

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The mental health of the farming community across industrialised nations has long been a major concern. Using an adapted procedure for a systematic literature review of observational epidemiological studies reporting prevalence (informed by the Joanna Briggs Institute method), this paper reviews peer-reviewed literature that explicitly compares farmer and non-farmer mental health (*n*=48). In doing so, it provides a central and accessible evidence base for researchers and practitioners, and simultaneously reveals a stark lack of consensus; specifically, 54.0 per cent of measures deployed to assess farmer mental health determined it to be the same as or even better than non-farming populations. This ambiguity sits in sharp contrast to the unequivocally worrisome farmer suicide statistics. Informed by the literature, the paper discusses potential reasons for this mismatch, including (i) farmers' progression through a different 'pathway' to suicide that is not always preceded by mental illness, and (ii) a failure of current methods to accurately gauge the mental health status of farmers. The paper concludes by recommending more research into farmers' 'pathway' to suicide, and highlights the need for a dedicated and multi-disciplinary programme of methods research that will afford a more culturally appropriate and effective means of understanding mental health in the farming community.

Keywords: farmers; psychological morbidity; suicide; mental health

Introduction

Psychological morbidity is unequivocally recognised as a significant health issue besetting farmers across industrialised nations [1] and globally [2]. A series of high-profile crises, such as animal disease outbreaks [3-6], extreme weather events [7-10] financial volatility [6,11] and, rural social change [11,12], alongside well-publicised suicide statistics [11], have perpetuated concern for a mental health crisis in agriculture and the vulnerability of the farming population. The 'stress iceberg model' [11,13] conceptualises this concern, by suggesting that for every farmer suicide, there are many others struggling below the surface; or as Lobley *et al.* [11] describe, the higher suicide rate amongst farmers is perhaps "the most egregious indicator of mental distress within the farming population" (p. 170). This supports qualitative evidence and media reports [14] that the farming community across developed

market economies, is indeed suffering from high levels of mental health difficulties, such as anxiety and depression [15-19]. However, despite notable research effort, the literature that has assessed the mental health status of farming is vast and disparate, emerging from different academic disciplines and deploying a range of methods. The previous research culminates in a disjunctive body of knowledge from which it is difficult to achieve a balanced overview or conclusion regarding the relative mental health status of the farming community (Janzen *et al.* [14], also note this lack of consistency). For example, work by Rudolphi *et al.* [20] suggest as many as 71 per cent of US farmers met the criteria for generalized anxiety disorder (GAD), compared to just 18.1 per cent of US adults who experienced 'any anxiety disorder' in the past 12 months. They observed a similar pattern for depression, with 53 per cent of farmers meeting the criteria for depression, compared to a 12-month prevalence of just 6.7 per cent amongst US adults for 'major depressive disorder'. Similar support for the idea that farmers are disproportionately affected by poor mental health is provided by numerous others [21-24]. However, other studies robustly contradict the consensus, for example, Scarth *et al.* [25] found just 9.8 per cent of surveyed farmers had experienced 'high depressive symptoms', compared to 17.3 per cent amongst the general population, a sentiment observed by numerous others [26-29].

As such, this review is driven by a single research question: *Are farmers more likely to experience psychological morbidity than non-farmers?* In order to answer this question, the review uses an adapted procedure for a systematic review (sharing many of the features of the 'Joanna Briggs Institute method' [30]) approach to synthesise existing academic evidence (published between 1999-2021) on the relative prevalence of psychological morbidity in the farming community. In doing so, not only does the paper provide a central evidence base for researchers and practitioners alike, it reveals a surprising lack of consensus regarding the prevalence of psychological morbidity amongst the farming community, which sits in sharp

contrast to the consistently worrisome farmer suicide statistics (for example, according to ONS data, in the UK between 2011-2015, suicides amongst male skilled agricultural workers had a standardised mortality ratio (SMR) of 169, where an SMR of 100 would indicate the same level as the general population [11], see also [22,31-36] all of which show consistently elevated rates of suicide amongst the farming community). The paper discusses this overall lack of correlation between farmers' mental health status and suicide, and suggests findings from existing approaches should be interpreted with caution. The paper concludes by highlighting the need for a dedicated programme of methods research, to develop a culturally appropriate and effective means of understanding the mental health status of the farming community.

Focus of the paper

A wealth of evidence documents sources of stress amongst the agricultural community [see for example 4,8,37,38-40] and culminates in a clear consensus: farming is a stressful occupation. Sources of stress in agriculture – indicative of the outcomes of agricultural restructuring in developed market economies [41] – are extensively documented and as such, fuel concern for a mental health crisis in agriculture. However, as Lobley *et al.* [11] themselves reflect, in relation to their own data, feelings of stress, disenchantment and dissatisfaction reported by farmers do not necessarily equate to, nor indicate, clinical levels of depression (or other mental illnesses). This reflects Price and Evans' [4] critique of over-use of the terms 'rural stress' and 'farming stress', which they argue have rendered them 'colloquial catch-alls' for a plethora of health outcomes. Furthermore, stress is a subjective concept, and in some contexts, acts as a motivating force that does not always manifest in a challenge to mental well-being [3] or can force positive changes at the farm level [9]. Evidence also 'strongly' suggests farmers are particularly able to adapt to, handle and resist

work-related stress [42] whilst benefiting from farm-specific 'protective factors' [22] such as social support and sense of belonging.

Whilst a lot of the 'stress' literature *assumes* the likely impact of stressors on farmer mental health and fails to precisely define what it means by stress [5], a body of literature has also tested (through objective measures or purposeful qualitative assessment) the mental health impacts of farming stressors [37,43-49], empirically demonstrating psychological morbidity as a sequela of specific occupational stressors. Whilst this literature gives credence to the stress iceberg thesis [11] and the notion of a mental health crisis in agriculture happening 'below the surface', to accept a consensus regarding the *relative* mental health vulnerabilities of the farming community purely on the basis of this literature would be to conflate stressors, stress and psychological morbidity. The stress literature simply does not afford any conclusions regarding the prevalence of psychiatric morbidity amongst the farming community, relative to the wider population. As such, this paper *specifically* reviews the literature pertaining to 'farmer versus non-farmer' mental health.

Method

The review method applied is an adapted procedure for a systematic literature review of observational epidemiological studies reporting prevalence, sharing many of the features of the 'Joanna Briggs Institute method' [30]. It is characterised by clearly defined inclusion/exclusion criteria (as per the CoCoPop framework [38]), an assessment of methodological quality (informed by the 'critical appraisal checklist' [38]) and a qualitative/narrative synthesis of the key findings (one of the many approaches to presenting results identified by Munn *et al.* 2014; 2015 [30,50]).

Eligibility criteria

The review includes studies that met the following criteria; studies that provide an assessment of the prevalence or level of any mental health condition using any measure (standardised, validated or otherwise) [Condition] amongst adult farmers[1] *and* non-farmers (i.e. allowing for explicit comparison between the populations) [Population], and were conducted in Europe, North America or the Antipodes and published between 1st January 1999 and 1st November 2021 [Context]. Studies were excluded based on the following criteria: studies that did not provide a comparison of the prevalence or level of psychological morbidity between farmers and non-farmers; studies that were conducted outside the specified timeframe and geographical focus; studies that solely referred to (migrant) farm labourers (it was felt their experiences were substantially different, warranting a more specialised research focus); studies not published in peer-reviewed journals; studies not published in English; studies that did not publish original research (i.e. literature reviews or commentaries); and studies that were solely concerned with suicide (which is considered an outcome rather than a condition).

Search procedure

Databases searched were: Web of Science (WoS) Core Collection (which included all editions / indexes, including Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index), PubMed, ProQuest, APA PsycArticles. Where possible, search outputs were restricted to English language articles from Europe, North America and the Antipodes and were limited to studies published between 1999 and 2021 (as above). The regions included in the review share farming traditions and are united by experiences of the same or similar pressures pertaining to agricultural restructuring, shifting market conditions, policy reforms and climate change which are potentially important factors

[1] Note, we did not strictly define 'farmer', using the wildcard farm* instead (see Supplementary Information: Box 1 for search terms and syntax). This was a deliberate choice to see the variety of ways farmers are represented in the literature. The definition adopted in each paper is reported as a variable in Table 1.

in the context of farmer mental health, that have characterised the previous two decades.

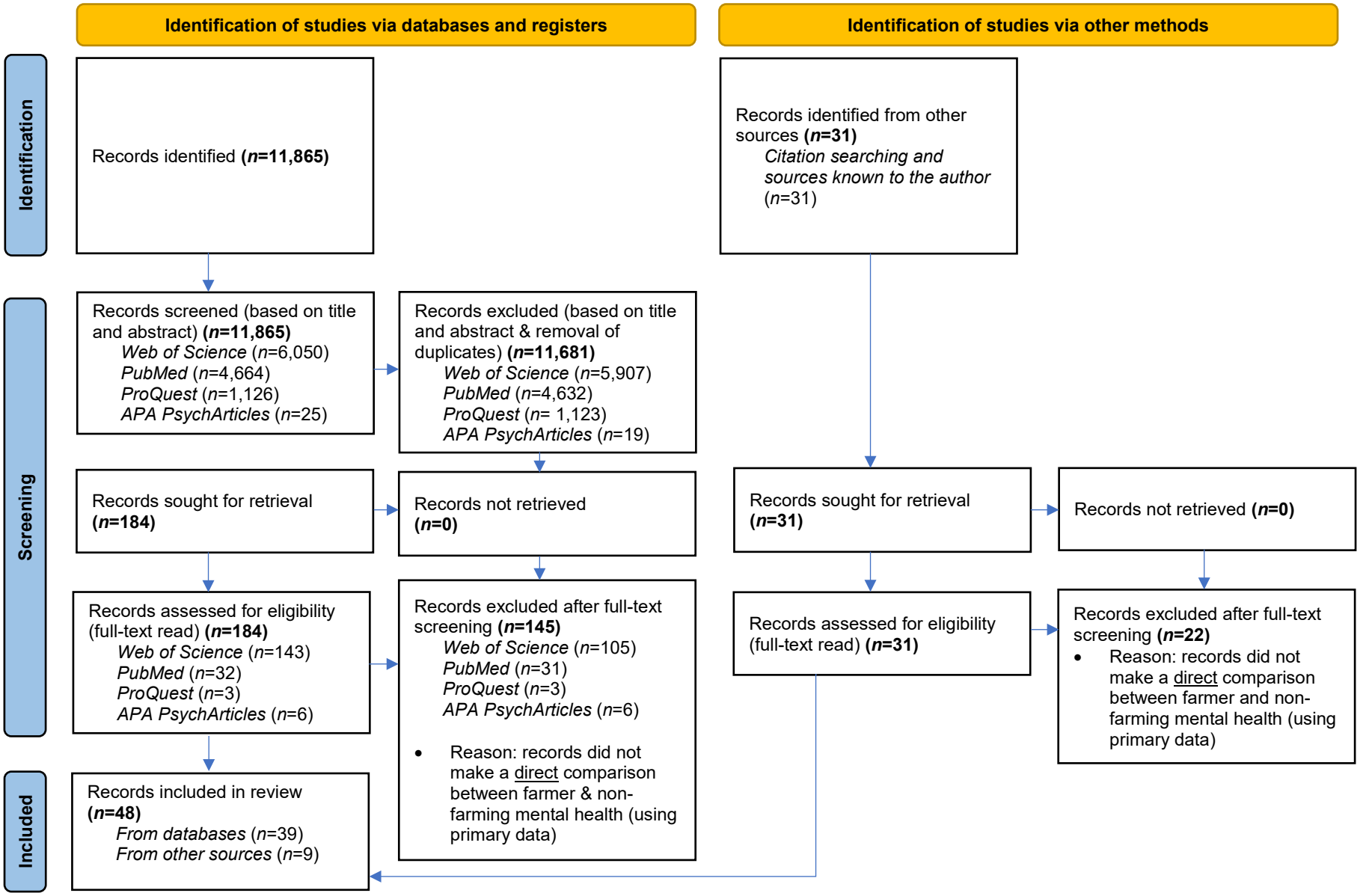
Although specifically concerned with evidence pertaining to the 'farmer versus nonfarmer mental health', the search criteria used were relatively broad (see appendix). This reflected the fact that comparisons between farmer and non-farmer levels of psychological morbidity were not always the sole focus of the paper, but an incidental finding or subsidiary conclusion. As per the PRISMA flow diagram in Figure 1, database searches initially yielded 11,865 results. As part of the first round of screening, duplicates and articles deemed substantively irrelevant on the basis of their titles and abstracts were excluded. Where a paper's ability to address the research question was unable to be confirmed by the title/abstract alone, but it remained considered to be potentially relevant, the paper was marked for retrieval and full-text review. A total of 184 records were sought for retrieval and 184 full texts were retrieved and subsequently read. Following the full-text screening, a total of 39 papers were retained (i.e. where they met all the inclusion criteria, including – critically – the comparison between the level or prevalence of farmer and non-farmer psychological morbidity).

In a parallel phase, sources known to the author and sources identified in a bibliographic screening of the 39 records identified from the database search and other relevant papers (e.g. literature reviews or commentaries) were retrieved and read (n=31). This was a more qualitative (although no less important) part of the search and relied on the author's knowledge of the subject area and wider reading and reflected the specificity of the research question. A further 9 papers were retained and added to the existing database, meaning the final database comprised of 48 records. This process was done by a single researcher (the author).

Whilst every effort has been made to capture the necessary literature that makes an explicit comparison between farmer and non-farmer mental health, where it is not a central

focus of the paper, it is likely that this may not have emerged as part of the systematic literature search. As such, this review relies – at least in part – on sources that emerged from the author's wider reading and snowballing from bibliographic searches, with the systematic database search just one element of this process.

Figure 1 PRISMA flow diagram: literature identification



Synthesising key findings and assessing methodological quality

The 48 sources were imported into QSR NVivo 12 where they then underwent an initial round of analysis using the classification feature. In order to enable a synthesis of the key findings, records were classified according to the following variables which formed the basis of the analysis: *Year of data collection; Country; Target population (definition of farmer); Measure of psychological morbidity; Condition measured and criteria for caseness; Farmers' comparative mental health ('Better', 'Same' or 'Worse' than non-farmers); Source of comparison to non-farmers; Timeframe of comparative data*. These criteria form the basis of the analysis and synthesis table (see *Supplementary Information: Table 1*).

In order to assess methodological quality, we devised two assessment criteria, based on/informed by two criteria from the JBI 'critical appraisal checklist', namely: (i) Were valid methods used for the identification of the condition? and; (ii) Was the condition measured in a standard, reliable way for all participants? Rather than a binary classification, records were given a score out of four, as per the criteria outlined in Table 1. Although the review presents the *whole* body of literature pertaining to farmer versus non-farmer mental health (regardless of quality), distinguishing between methodologically lower- and higher-quality studies forms an important step in the analysis and interrogation of the available data and is offered to assist readers in their own judgment of the literature.

Table 1 Methodological quality assessment criteria: scoring system

JBI checklist criteria	**Assessment criteria used**	**Score out of 1**
#6 Were valid methods used for the identification of the condition?	Use of an internationally-recognised / standardized, validated measure or scale e.g. K10	1
	Any other method of assessment	0
JBI checklist criteria	**Assessment criteria used**	**Score out of 3**
#7 Was the condition measured in a standard, reliable way for all participants?	Fully equitable comparison between farmer and non-farmers where any comparison uses data collected in the same study, i.e. data was collected .. 1. at the same time *and* 2. in the same place *and* 3. using the same method of assessment	3
	Partly equitable comparison between farmer and non-farmers where (typically secondary) data used for comparison shares <u>two</u> of the following three characteristics: 1. at the same time *or* 2. in the same place *or* 3. using the same method of assessment	2
	Partly equitable comparison between farmer and non-farmers where (typically secondary) data used for comparison shares <u>one</u> of the following three characteristics: 1. at the same time *or* 2. in the same place *or* 3. using the same method of assessment	1
		Maximum total score 4 4=High 3-2=Medium 1=Low

Review of the literature findings: Are farmers more likely to experience psychological morbidity?

An introduction to the papers reviewed

By way of introduction to the 48 papers reviewed, Figure 2 shows the number published across the 22-year period.

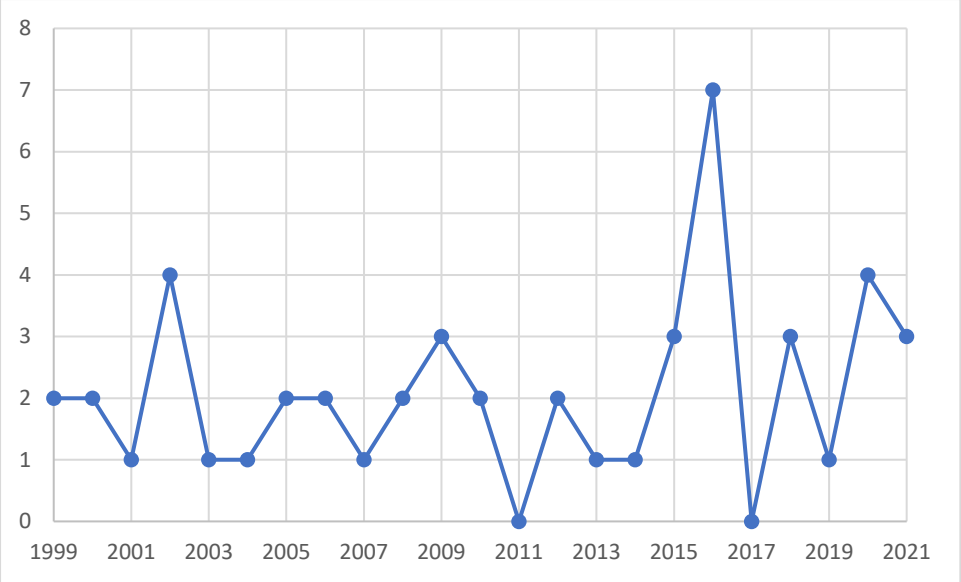


Figure 2 Number of papers examining the comparative mental health status of farmers by year (n=48)

A total of 33 countries were represented across the 48 studies (Figure 3) (although note, the searches were *only* concerned with Europe, North America and the Antipodes only). One paper [51] was an EU-wide study, utilising data from 28 countries[2]. Studies from the US, United Kingdom and Australia accounted for two-thirds of the studies reviewed.

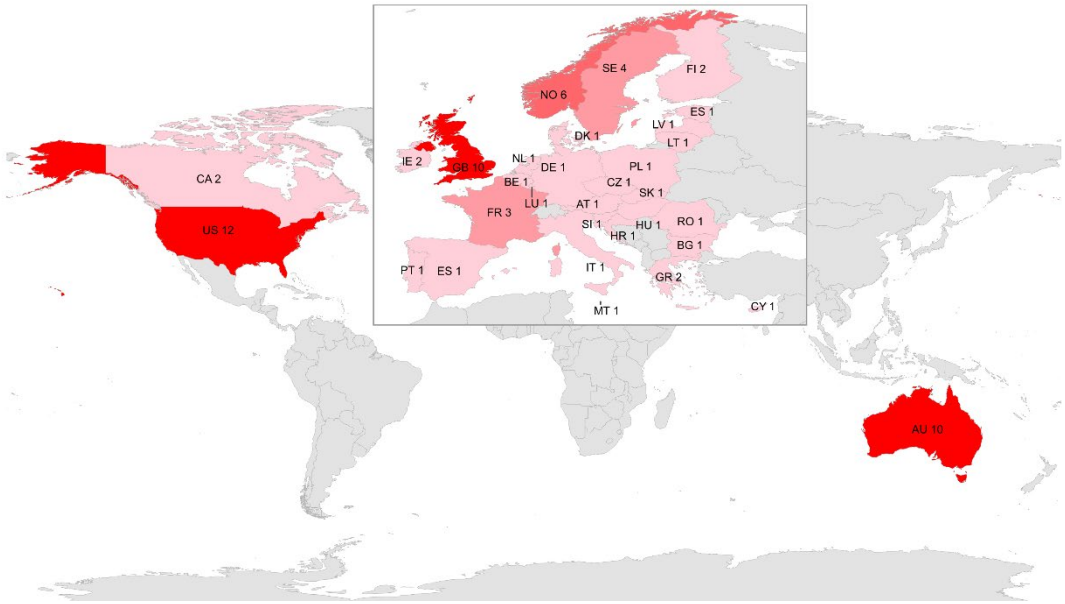


Figure 3 Map indicating where papers examining the comparative mental health status were conducted (1999-2021) (n=48)

[2] Belgium, Bulgaria, Romania, Slovenia, Slovakia, Finland, Sweden, UK, Croatia, Denmark, Germany, Estonia, Greece, Spain, France, Ireland, Italy, Cyprus, Latvia, Lithuania, Luxemburg, Hungary, Malta, Netherlands, Austria, Poland and Portugal

Synthesis of key findings

Supplementary Information: Table 1 presents 248 (discrete) measures/assessments of mental health from across the 48 different studies; the nature of these is summarised in Figure 4. The majority contradict the commonly appropriated belief of a mental health crisis in agriculture (134/248 or 54.0 per cent measured levels of mental ill-health amongst farmers to be akin to or better than the wider population), whilst 114/248 or 46.0 per cent observed more worrisome levels amongst the farming population.

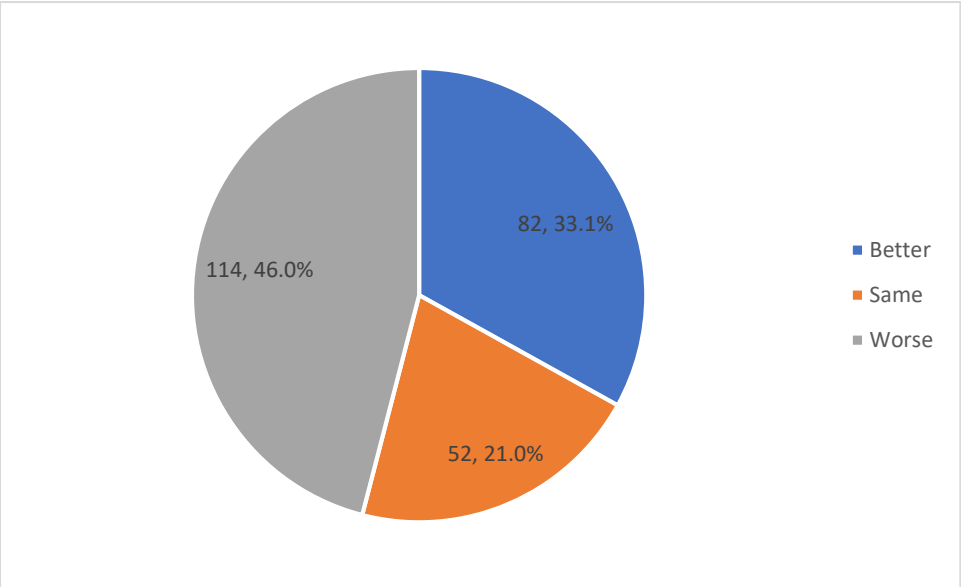


Figure 4 Breakdown of the outcomes of the (n=248) measures/assessments of mental health used – showing farmers' mental health as 'better', 'the same' or 'worse'

Classification of papers according to the *overall* degree to which they support or contradict the idea that farmers are disproportionately affected by psychological morbidity offers similarly indeterminate conclusions (Figure 5). This classification saw papers categorised according to the *sum of all of their measures*; 'All measures used in the paper support the idea that farmers are disproportionately affected'; 'All measures used in the paper show farmers to be similarly impacted'; 'All measures used in the paper show farmers to have better mental health status'; and 'Measures showed mixed results'. For example, a paper where five out of five measures used all supported the idea that farmers are disproportionately affected by psychological morbidity was classified as 'All measures used

in the paper support the idea that farmers are disproportionately affected'. Just 15/48 (31.2 per cent) of papers were classified as offering unambiguous support (across all measures) to the idea that farmers are disproportionately affected by mental ill-health when compared to non-farming counterparts. A total of 5/48 papers (10.4 per cent) showed psychological morbidity to be *similar/the same* across all measures used, and a further 9/48 (18.8 per cent) measured farmer mental health to be *better* across all measures. The remaining 19 studies (39.6 per cent) offered more nuanced findings – where multiple assessments/measures of psychological morbidity utilised may have offered contradictory findings, or highlighting important differences *within* the farming community.

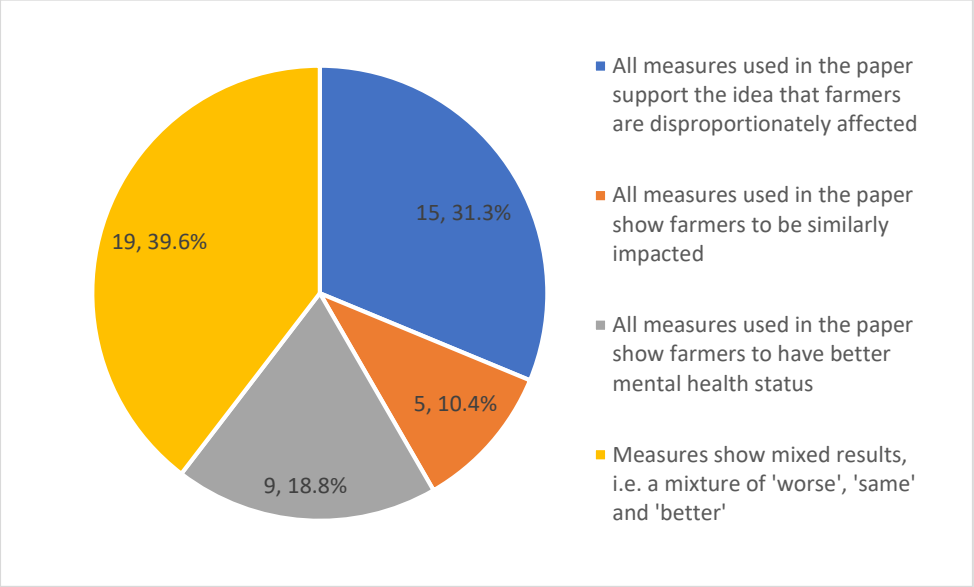


Figure 5 Categorisation of papers according to the overall outcomes of their measures/assessments of mental health (n=48)

As per Table 2, 40 out of the 48 studies utilised internationally-recognised, standardized / validated measures of mental health, and just over half of the studies reviewed (27 out of the 48) made direct or 'equitable comparisons' between farmer and non-farmer mental health, i.e. data was collected from both farming and non-farming samples within the same study, within the same timeframe and using the same methods.

Table 2 Breakdown of 'method of comparison' used by each paper

	Validated, standardized method? + score out of 1	Comparison emerges from data collection from the *same* study? ('equitable' comparison) + score out of 3	Where 'no', secondary data used for comparison emerges from data collected …			Total score (High, Medium & Low)
			… from within the same country?	*… in the same year?*	*… using the same method / assessment of mental health?*	
Rudolphi [20]	**Yes** (1/1)	**No** (1/3)	Yes	No	No	2 (M)
Bjornestad [53]	**Yes** (1/1)	**No** (1/3)	Yes	No	No	2 (M)
Carruth and Logan [54]	**No** (0/1)	**No** (1/3)	Yes	No	No	1 (L)
Jones-Bitton [23]	**Yes** (1/1)	**No** (1/3)	No	No	Yes	2 (M)
Booth and Lloyd [55]	**Yes** (1/1)	**No** (2/3)	Yes	No	Yes	3 (M)
Hounsome [21]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Eisner *et al.* [56]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Peck [37]	**Yes** (1/1)	**No** (1/3)	Yes	No	No	2 (M)
Crimes and Enticott [5]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	4 (H)
McLaren and Challis [22]	**Yes** (1/1)	**No** (2/3)	Yes	Unknown	Yes	3 (M)
Gunn *et al.* [57]	**Yes** (1/1)	**No** (2/3)	Yes	No	Yes	3 (M)
Logstein [59]	**Yes** (1/1)	**No** (2/3)	Yes	No	Yes	3 (M)
Logstein [43]	**Yes** (1/1)	**No** (2/3)	Yes	No	Yes	3 (M)
Guillien [60]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Booth et al. [61]	**No** (0/1)	**No** (2/3)	Yes	No	Yes	2 (M)
Kallioniemi [45]	**No** (0/1)	**No** (1/3)	Yes	No	Unknown	1 (L)
Stallones and Beseler [26]	**Yes** (1/1)	**No** (1/3)	Yes	No	No	2 (M)
Stiernstrom [29]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Thelin [28]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Scarth *et al.* [25]	**Yes** (1/1)	**No** (2/3)	Yes	No	Yes	3 (M)
Rayens *et al.* [27]*	**Yes** (1/1)	**No** (1/3)	Yes	Unknown	Unknown	2 (M)
		No (1/3)	Yes	Unknown	No	
Judd *et al.* [62]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Brew *et al.* [63]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Edwards *et al.* [8]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Merchant *et al.* [64]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Thomas *et al.* [65]	**Yes** (1/1)	**No** (1/3)	Yes	No	Yes	3 (M)
Sanne *et al.* [66]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Torske *et al.* [67]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Letnes *et al.* [24]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Wheeler *et al.* [68]	**Yes** (1/1)	No** (2/3)	Yes	No	Yes	3 (M)
Stain *et al.* [48]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	4 (H)
Janzen *et al.* [14]	**No** (0/1)	**Yes** (3/3)	-	-	-	3 (M)
Demos *et al.* [69]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Lizer and Petrea [70]	**Yes** (1/1)	**No** (1/3)	Yes	Unknown	Unknown	2 (M)
Syson-Nibbs *et al.* [71]*	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
		No	Yes	Unknown	Yes	
Harrison and Ross [72]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Kennedy *et al.* [73]	**No** (0/1)	**Yes** (3/3)	-	-	-	3 (M)
Kennedy *et al.* [74]	**No** (0/1)	**Yes** (3/3)	-	-	-	3 (M)
Gevaert *et al.* [51]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	4 (H)
Kolstrup *et al.* [75]	**Yes** (1/1)	**No** (1/3)	No	Unknown	Yes	2 (M)
Torske *et al.* [76]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Cohidon *et al.* [77]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Stallones and Beseler [78]	**Yes** (1/1)	**No** (1/3)	Yes	No	No	2 (M)
Hanigan *et al.* [79]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Furey *et al.* [80]*	**Yes** (1/1)	**No** (1/3)	No	No	Yes	2 (M)
		No (1/3)	No	No	Yes	
Lavender *et al.* [81]	**No** (0/1)	**Yes** (3/3)	-	-	-	3 (M)
Fragar *et al.* [82]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**
Earle-Richardson [83]	**Yes** (1/1)	**Yes** (3/3)	-	-	-	**4 (H)**

* Studies compared primary data to multiple other data sources
** Judgment based on primary data collected during the study

Even when broken down by methodological quality (as per the criteria outlined in Table 1), no consensus comes into focus (Figure 6); in fact, mixed/nuanced results were more common amongst exclusively higher quality papers (65.2 per cent of 'high quality' papers showed mixed/nuanced results, compared to 39.5 per cent across all papers).

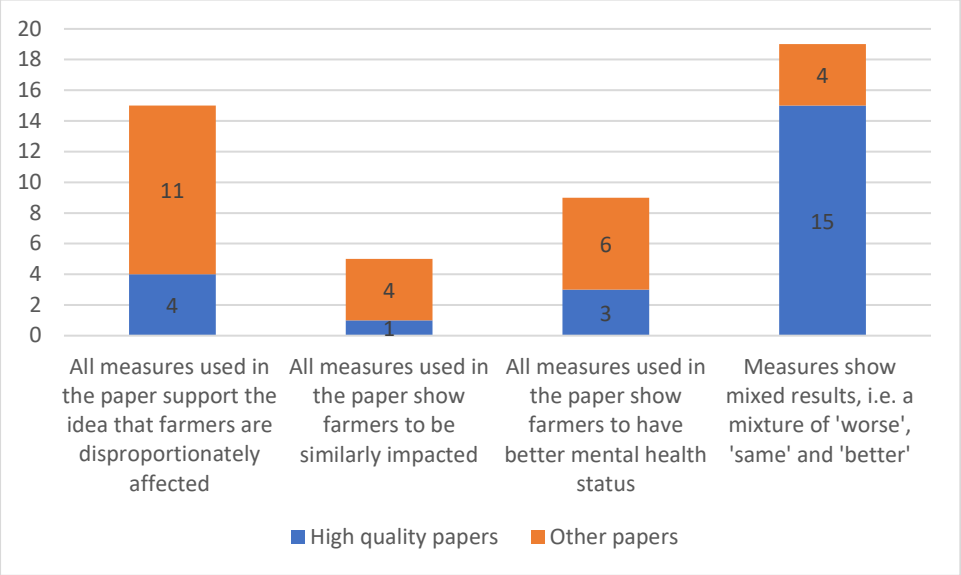


Figure 6 Categorisation of papers according to the overall outcomes of their measures/assessments of mental health by paper quality (n=48)

A critical discussion of the papers and their findings are now presented. A summary of the papers and their key variables, including their geographical focus, time of data collection, target population, measure of psychological morbidity, condition and criteria used, farmers' relative mental health status (better, same or worse), source of comparative non-farmer data, and a summary of quality is presented in *Supplementary Information: Table 1*.

Supporting the consensus: a mental health crisis in agriculture (n=15)

Work by Rudolphi *et al.* [20] with Midwestern farmers and ranchers 18-37 years old, provides unequivocal support for the idea of a mental health crisis in agriculture. Overall, a total of 71 per cent of farmers met the criteria for GAD (indicative of a GAD-7 score of ≥5), compared to 18.1 per cent of US adults who experienced 'any anxiety disorder' in the past 12-months (citing National Institute of Mental Health[3]). The pattern was similar for depression, with just over half of farmers (53 per cent) meeting the criteria for depression (PHQ-9 score ≥5), compared to a 12-month prevalence of 6.7 per cent amongst US adults for 'major depressive disorder' (citing National Institute of Mental Health[4]). Although they speculate that individuals with mental health concerns may have been more likely to respond to the survey than otherwise healthy individuals, resulting in an overestimation of the prevalence of anxiety and depression, they also note how the prevalence of psychological morbidity observed in farmers observed is 'similar' to the amount of 'any level' anxiety observed by Jones-Bitton *et al.* [23] in their study of Canadian farmers.

Subsequent work in the Midwest [53] used a random sample of agricultural producers with at least 1000 acres or who owned a dairy farm, suggests a comparatively lower percentage of farmers suffering anxiety compared with young farmers surveyed by Rudolphi *et al.* (above), *but* continues to support the idea that farmers are disproportionately impacted by anxiety. Specifically, 27 per cent of farmers met the criteria for generalized anxiety disorder (GAD-7 ≥5), versus 19.1 per cent of US adults when compared to national data (although the figure they cite actually refers to the 12-month prevalence of 'any anxiety disorder' rather than GAD, which was even lower at 2.7 per cent – inadvertently

[3] Note that this figure differs from that of Bjornestad *et al.* who also cite the National Institute of Mental Health for the figure on 'generalized anxiety disorder'. They are both referring to the NIMH data (which is based on the National Comorbidity Survey Replication data collected between 2001-2003), but the figures Rudolphi *et al.* are referring to match the pre-2007 analysis of the data (aligning with Kessler *et al.* in their 2005 analysis [78]), and Bjornestad *et al.* are referring to the more contemporary analysis, available here [79]

[4] From the pre-2007 analysis of the NCS-R data.

strengthening their argument further) (National Institute of Mental Health, online[5]). They do not attempt to compare observed levels of depression amongst agricultural producers to the wider population. Notably, they posit the prevalence of both anxiety and depression are likely to be higher in reality, owing to the fact individuals with poor mental health may interpret or respond to surveys differently.

Also in the US, Carruth and Logan [54] explored the prevalence of depression amongst farm women. Overall, 24 per cent self-reported experiencing depressive symptoms in the 12 months prior to the 1998 survey. And whilst, the authors claim the prevalence of depression 'exceeds' the national prevalence evident in the 1974/1975 National Health Survey [86], its contribution to the overall 'farmer versus non-farmer' discussion is limited given the different survey timings and the different measures of caseness (the National Health Survey utilised CES-D).

In a US retrospective cohort study, Lavender *et al.* [81] used the Georgia Violent Deaths Reporting System to explore circumstances surrounding workers' deaths, by occupation groups. In contrast to the other retrospective cohort studies explored as part of this review [61,73,74], farmers were more likely to have 'Current depressed mood' as a circumstance surrounding their death, than the overall occupations figure (36.3 per cent versus 31.9 per cent). Furthermore, the prevalence of a 'Current mental health problem' was higher than the all occupations overall figure (31.8 per cent versus 29.4 per cent). They considered farming to be a 'high risk occupation' for suicide (and homicide).

Similarly, with reference to Canadian farmers, a 2015/16 survey by Jones-Bitton *et al.* [23] showed the percentage of probable cases for anxiety (28.8 per cent amongst males; 42.8 per cent amongst females) and depression (12.5 per cent amongst males; 18.9 per cent

[5] This table includes updated data as of July 19, 2007. Updates reflect the latest diagnostic, demographic and raw variable information.

amongst females), indicated by HADS scores ≥11 (i.e. 'moderate' and 'severe'), were 'notably' higher than the reported levels of anxiety (12.5 per cent amongst males; 19.0 per cent amongst females) and depression (6.9 per cent amongst males; 6.9 per cent amongst females) in the UK general population in 2001/02 [87]. Whilst their data supports the notion that farmers are disproportionately affected by anxiety and depression, the use of older, overseas (UK) general population data means the comparison should be interpreted with caution.

A self-administered postal survey of farmers in South West England in 1995 [55] lends further support to the notion that farmers are disproportionately affected by psychological morbidity. Analysis revealed 35 per cent of farming respondents met criteria for psychiatric morbidity (GHQ score >5), compared to an average of just 30.1 per cent in the region as a whole and 31 per cent in England, Wales and Scotland in 1984-1985 (as per the Health and Lifestyle Survey [88]). The mean GHQ score for farmers in the South West region (which included Devon, Cornwall and Somerset) measured by the survey was 4.0 – higher than that of the general population in the region[6] (3.42) (as per 1984-1985 Health and Lifestyle Survey data – Duncan *et al.* [89]). Again, the comparison of data from different timeframes should be noted.

Building on the seminal work of McGregor *et al.* [90], Hounsome *et al.* [21] used the GHQ with farmers, their spouses, and non-farming attendees, at agricultural shows in the UK. Farmers' and spouses' mean score was significantly higher (10.67) than the non-farmers surveyed (9.46) – indicative of higher levels of psychological distress (a difference that was significant at the $P < 0.001$ level). Farmers' mean scores were persistently higher than the non-farmers surveyed when broken down by various demographic characteristics (including gender, age, employment situation, supervisory role and rural residence), but these

[6] This included Devon and Cornwall only

differences were only statistically significant for certain sub-groups[7]. The prevalence of GHQ scores ≥12 (indicative of clinically significant psychiatric disorders) was also higher amongst farmers than in non-farmers (35 per cent versus 27 per cent). Although conclusive, Hounsome and colleagues recognise their results emerge from an unavoidably biased sample of farmers, well enough to attend agricultural shows, and thus posit, "the true level of psychiatric morbidity among the farming community maybe much higher than was captured" (p. 508).

Also in the UK, the 'Tideswell health survey' [71], Syson-Nibbs *et al.* explored the prevalence of depression and anxiety in primary farmers (those for whom farming was their sole occupation), secondary farmers (those who had additional employment alongside farming) and non-farming patients registered at a GP practice in the Peak District National Park. Clinical cases of depression (indicated by a HADS-D ≥11) were observed amongst 5.9 per cent of primary farmers – almost double the prevalence observed non-farming patients (3.3 per cent), and notably more than the rate in the UK general population (3.6 per cent) [91]. Cases of depression were even lower amongst secondary farmers (2.7 per cent). The prevalence of anxiety varied only marginally between primary and secondary farmers (9.4 and 10.7 per cent respectively), but was lower (6.1 per cent) amongst non-farmers. Despite this difference in absolute percentages, Syson-Nibbs *et al.* conclude there is "no clear variation between the occupational groups", for anxiety (p.225).

UK research into the impact of various animal disease outbreaks consistently, perhaps unsurprisingly, found levels of psychological morbidity to be above the level in the wider UK population. Firstly, Eisner *et al.* [56] sought to measure the impact of the 1996 'beef crisis' on farmer mental health using data from a 1994 mental health study as a baseline. Anxiety or

[7] males, those in non-supervisory roles, those residing in rural areas (all at $P < 0.001$) and those aged 45-54 and 55-64, those who were self-employed and those not in paid employment (all at $P < 0.005$)

depression (considered together) was more prevalent in farmers than controls in *both* 1994 and 1996 (37.7 per cent of farmers versus 23.6 per cent of age matched controls in 1994; 34.0 per cent of farmers versus 15.1 per cent of age-matched controls in 1996). Surprisingly, given the fears surrounding the 'BSE crisis', the authors note the overall rates of depression and anxiety decreased in both farmers and controls over the study periods. Using logistic regression to explore the effect of being a farmer on the likelihood of being depressed or anxious in 1996, Eisner *et al.* observed being a farmer in 1994 increased the chances of suffering from depression or anxiety in 1996, although having had a HAD score of ≥8 in 1994 increased the probability of having depression or anxiety 'much more', regardless of farming status. Later, Peck *et al.* [37] explored the impact of food and mouth disease (FMD) on mental health. They found one-third of farmers in the Highlands, and two-thirds of Cumbrian farmers had GHQ scores indicative of psychological morbidity – 'substantially above' the one-week prevalence rate of neurotic disorder in the UK observed by Paykel *et al.* [92], albeit using a different measure of psychological morbidity (a difference the authors suggest is 'unlikely' to explain the difference in prevalence). Most recently, using measures of subjective well-being (SWB)[8], Crimes and Enticott [9] concluded participating farmers (including those with and without bTB) perceived SWB to be lower than observed in the wider population (when compared to ONS data collected in the same year).

Work with UK sheep farmers and retired farmers with a history of low-level exposure to organophosphate pesticides [72] adds further weight to the notion that farmers are more likely to suffer mental ill-health than the wider population (on the basis that farmers are more commonly exposed as an occupational group). Based on self-reporting measures for anxiety and depression (HADS-A & HADS-D), farmers had significantly higher mean scores than

[8] Subjective well-being (SWB) is derived from the difference between mental well-being (i.e., psychological functioning, life satisfaction and ability to develop and maintain mutually benefitting relationships, personal growth, purpose in life and self-esteem) and mental illness (i.e., mental disorders affecting mood, affect and functioning)

unexposed controls (even after controlling for demographic and psychosocial risk factors). However, use of more in-depth Structural Clinical Interview schedule – which measured psychiatric diagnosis/caseness – suggest exposure was *only* related to anxiety. The authors note the lack of accepted definitions of 'acute' and 'low-level' exposure could mean the study may have 'inadvertently' included participants with undiagnosed acute toxicity resulting in an *over exaggeration* of the relationship between exposure and negative mental health outcomes. Inversely, owing to strict inclusion/exclusion criteria (which excluded more than 60 per cent of potential participants), it may be that the study findings actually *underestimate* the risk associated with organophosphate exposure, by initially excluding participants that were particularly vulnerable to the neurotoxic impacts of organophosphates. Given how pesticide exposure/poisoning is commonly associated with farming as an occupation, this work (and others that identify a positive association between pesticide exposure and psychiatric morbidity [26,44,45,93-98] adds weight to the hypothesis that farmers are more likely to suffer from psychiatric morbidity than the wider population, although – of course – farming is not always associated with pesticide exposure.

McLaren and Challis [22] observed higher levels of depression amongst Australian male farmers when compared to a group of randomly selected males residing in rural areas [99] (both used the Zung Depression Score). In a later Australian study, Gunn *et al.* [58] used the K10 scale to assess levels of psychological distress. In their sample, 34.6 per cent of farmers were deemed to be suffering from 'high levels' of distress (although they do not define a 'cut off' for this), compared to just 10.2 per cent of the wider rural population (as per rural population data collected in 2004, 2005 and 2006 [100]), and displayed 'significantly higher levels of distress' than the national population (when compared to national population data collected in 1997, [101]).

An EU-wide study of self-employed persons [51] gives further weight to the idea of a mental health crisis in farming, relative to other occupations. It found farmers to have the poorest average mental well-being score (mean 1.67), measured using WHO-5 wellbeing index (compared to 'Dependent own account worker and freelancer' 1.57; 'Independent own account worker and freelancer' 1.52; 'Manager: small employer' 1.52; 'Manager: medium to big employer' 1.36 – where a higher score is worse).

Using a version of the Copenhagen Psychosocial Questionnaire (COPSOQ), Kolstrup *et al.* [75] found Swedish dairy and pig farmers to have worse self-reported mental health than Danish workers [102] (18.9 average score versus 19.8 – a significant difference at the $p \leq 0.05$ level).

In an Irish study of active farming men aged 18-80, Furey *et al.* [80] observed what they describe as 'low levels of mental distress' amongst the farming community with 80 per cent of farmers scored 4 or less on the PHQ scale. However, they note that this proportion is greater than that observed in a general population sample (75.5 per cent) [103]. They also observed a similar proportion of farmers with no or minimal anxiety (81 per cent scoring 4 or less on the GAD) – a greater proportion than observed in a standard population sample (70.5 per cent). Despite their clear contribution to the 'farmer versus non-farmer' discussion, it is important to note the general population samples related to the US and German populations.

Contradicting the consensus

In contrast to the work presented up until this point, the following studies contradict widely propagated beliefs about a mental health crisis in agriculture by either demonstrating similar or – in some cases – definitively better levels of mental health amongst the farming community.

(i) Similar / the same (n=5)

A large 2012 survey by Logstein [59] found that the prevalence of farmers with a 'high symptom load of mental complaints' (indicative of a SCL-5 of 2.0 or above) was 11.6 per cent – 'approximately' the same amongst the general population (p.318) when compared to 1998 data using the same scale [104]. Later, Logstein *et al.* [43] used a sub-sample of dairy and potato farmers from the 2012 study (*n*=492) to explore the relationship between independence and farmer mental health. Mean SCL-5 values were 1.39 for all farmers (and – when broken down by farm type – 1.40 and 1.35 for dairy farmers and potato farmers, respectively), compared to a lower mean score of 1.33 for non-farmers (based on 1998 data [104]) – although, note that Logstein offers no judgment on their statistical similarity.

Using chi-square to explore potential difference, Guillien *et al.* [60] also found limited variation in the prevalence of anxiety and depression amongst four cohorts; healthy dairy farmers and non-farmers (i.e. those with 'normal spirometry'), and dairy farmers and non-farmers with chronic obstructive pulmonary disease (COPD). Specifically, they identified prevalence of 'possible/probable' cases of anxiety and depression (HADS-A & D score ≥8) was 'similar' amongst the four groups, i.e. farmers with and without COPD were no more likely to suffer from poor mental health outcomes than their respective, non-farming counterparts.

Further evidence of similarity between farming and non-farming populations comes from a retrospective case control study of male suicides in the South West of England between 1979 and 1994 [61]. The study found no 'significant' differences between farmers' and non-farming controls' contact with/use of various mental health services prior to their death by suicide, and, according to their analysis, farmers were "just as likely to have been given a psychiatric diagnosis" and were "equally likely to have been prescribed anti-depressants" (p.644).

In a Finnish study by Kallioniemi *et al.* [45], the prevalence of 'depression or melancholy' observed amongst farmers in the 'Farm2004' survey (14 per cent) was deemed 'on the same level' as the broader Finnish working population in 2003 [86]. As such, the authors firmly conclude depression (along with stress) "cannot be described as farmers' symptoms" (p. 166), although it is important to consider the assessment was fairly rudimentary – ascertained by one question ("Have you had, during the previous month, depression or melancholy?") and not using a validated mental health screening tool.

(ii) Better (n=9)

In their study of the relationship between pesticide use and depression (1992-1997), Stallones and Beseler [26] claimed, overall, US farmers and spouses in their sample had lower rates of depressive symptoms than the wider population (despite the association between pesticide poisoning and depressive symptoms demonstrated by their work). Specifically, depression was only observed in 3.9 per cent of male farmers, compared to a 12.7 per cent (lifetime rate) and 7.7 per cent (12-month rate) amongst males in the general population [105]. Although a comparatively higher prevalence was observed amongst farming women (9.5 per cent) than their male counterparts, it was lower than the rate observed in the wider female population (21.3 per cent lifetime rate, 12.9 per cent 12-month rate [105]). Whilst the study makes a stark contribution to the discussion, it is important to note general population data was based on a different measure of caseness (collected as part of the National Comorbidity Survey) and was collected prior to the farming data. In a later publication based on the same farmer and national population datasets [105], Stallones and Beseler [78] also highlight "general population rates are higher, in general, than those reported in this farm population" (referring to the overall figure of 6 per cent prevalence for the whole farming sample) (p. 576).

Stiernstrom *et al.* [29] make a compelling contribution to the debate by comparing data on death and admission to hospital amongst Swedish farmers, rural referents and urban referents between 1989-1996. Specifically, risk ratios for death or admission to hospital owing to mental disease amongst rural and urban referents were 2.94 and 5.13 respectively (where farmers were the reference population, i.e. had a risk ratio of 1.00) – a difference that was statistically significant at the <0.001 level. Between 1989 and 1996, farmers also had less hospital admissions owing to 'mental disease' per 10,000-person years, at just 21 per 10,000-person years, compared to 123 for rural referents and 258 for urban referents (also statistically significant at the <0.001 level). Based on both these measures, Stiernstrom *et al.* firmly conclude that "farmers had lower mortality and morbidity rates than the referents for mental disease" (p. 125). Later, using updated versions of the data (i.e. 1989-2001) based on the same sample of farmers, Thelin *et al.* [28] reiterate Stiernstrom's findings over the extended timeframe. According to Thelin and colleagues, the rate of fatalities owing to psychiatric disorders was 57 per 10,000 for farmers, compared to 62 amongst non-farming rural residents, and 120 for urban counterparts. The morbidity rate for psychiatric disorders (which included the number of deaths per 1,000 between 1989 and 2001 *or* hospital admissions between 1990-2002) was just 23 for farmers, compared to 53 and 86 for rural and urban referents respectively.

In a 1993/94 US study of principal male farmers, Scarth *et al.* [25] found, 12.2 and 7.4 per cent of farmers in Iowa and Colorado, respectively (or 9.8 per cent, overall) had experienced 'high depressive symptoms' (CES-D score ≥16) compared to 17.3 per cent amongst the general population (as per 1974/75 National Health Survey data [86]). Although the national survey also used the CES-D scale, the data was collected almost two decades prior to the farmer data collected, thus farmers' seemingly favourable mental health status

presented by Scarth and colleagues does not emerge from a direct comparison at one point in time.

In a study of 988 married farming couples aged 50 and over in the USA, Rayens *et al.* [27] found rates of depression to be lower than reported in other studies of aging populations. Specifically, in their study, 11.6 per cent of older farming males and 15.6 per cent of older farming females were suffering from depression (indicative of a CES-D score of ≥16), compared to 15.73 per cent and 22.82 per cent of older US (civilian, non-institutionalized) men and women, respectively (Shim *et al.*, 2011). However, these national figures do not make for a perfect comparison to the farmer data, emerging from a different measure of depression (PHQ-9 ≥5) and pertain to adults aged ≥55, rather than ≥50.

A retrospective cohort study by Kennedy *et al.* [74] observed farming-related suicides in the US were less likely to have a diagnosed mental health problem prior to suicide than non-farming counterparts (29.5 per cent versus 41.9 per cent) and less likely to have been in treatment for mental illness at the time of suicide (18.21 per cent versus 28.4 per cent). Another retrospective cohort study by the same lead author [73], this time in Australia, observed how farmers were less likely to have had a diagnosed mental illness prior to suicide (36 per cent versus 46 per cent) and less likely to received mental support more than six weeks prior to death (39.8 per cent versus 50.0 per cent).

In Australia, Hanigan *et al.* [79] observed farmers affected and unaffected by drought had better mean scores than non-farming counterparts (15.2 versus 16.0 amongst those affected, and 15.3 versus 16.6 amongst those not – where scores of ≥16 were indicative of 'moderate distress').

Nuanced findings (n=19)

The remaining 19 studies offer a more nuanced contribution to the 'farmer versus non-farmer' debate – where multiple assessments / measures of psychological morbidity

utilised may have offered subtly different or even wildly contradictory conclusions, or they may have highlighted important differences *within* members of the farming community. These studies are summarised in turn.

Initially, an Australian study by Judd *et al.* [62] offers limited support for higher rates of mental illness across key measures of mental health (K10, PANAS and SF-12-MCS) when compared to non-farming rural residents in the same study. On three out of the four measures, farmers scored 'better' than non-farmer counterparts surveyed. Specifically, farmers had lower mean K10 scores than their non-farming counterparts (16.31 versus 17.19) – indicative of lower levels of psychological distress; higher SF-12-MCS mean scores (52.11 versus 50.17) – indicative of better mental functioning; and higher positive affect (PA) (33.61 versus 31.78) – indicative of greater well-being. They scored similarly to the non-farming sample in negative affect (NA) (15.13 versus 15.90). Based on the results of this univariate analysis Judd *et al.* boast "a small but *significant* trend for farmers to report better [mental health] outcomes than do non-farmers in fact arises" (p. 4, emphasis added). *However*, these 'unexpected' findings do not hold true when explored via logistic regression analyses, in which binary forms of the three measures that differentiated farmers from non-farmers (K10, MCS and PA) were used as outcome variables. When farmer status was used as a sole predictor (Step 1), univariate results remain supported (i.e. farmers were more likely to be in the better outcome categories of binary MCS and PA), but when key demographic characteristics (gender, employment status and remoteness of residence) and personality variables (neuroticism, openness to experiences and conscientiousness) were added (Step 2) farmer status became non-significant across both mental health measures. No differences were found between farmers and non-farmers on the binary K10 variable (Step 1).

A longitudinal study Brew *et al.* [63] found Australian farmers/farm workers' self-reported mental health score to be lower (worse) than non-farmers, whilst their levels of

psychological distress (K10) and prevalence of 'current' depression (PHQ-9) were akin to rural, non-farm workers surveyed over the five-year period. After stratifying for remoteness, regional farmers showed no difference in their self-reported mental health score when compared to non-farm workers in regional areas, whereas farmers based in remote locations scored notably worse than their non-farm working counterparts in remote areas; a pattern that held true after adjusting for mediating factors, including experiences of financial hardship and experiences of adverse events. Although Brew *et al.* found farmers/farm workers were less likely than non-farmers to have seen a health professional for a mental health reason in the previous 12 months (9 per cent versus 16 per cent), the authors note this is more likely to reflect farmers' attitude to accessing health care for mental health needs – preferring to manage such issues themselves or feeling that nothing could help – rather than reflecting better mental health status. Although the study is one of few to offer a longitudinal insight into farmer mental health and offers a comparison between farmers and their rural counterparts (rather than the general or urban population), the loss of participants at each stage of data collection risks selection bias, particularly *if* those that left the study withdrew owing to mental health reasons.

Using data from the 2007 Rural and Regional Families Survey (RRFS) – a representative population-based survey of 8,000 adults living in agricultural areas of Australia – Edwards *et al.* [8] also found higher prevalence of mental health problems (indicative of a SF-36 score < 52) amongst farmers (including those affected and unaffected by drought) compared to those in non-agricultural employment (rates of 15.7 and 8.9 per cent respectively). Broken down by area type, unsurprisingly, this pattern holds true for farmers in areas affected by drought, but also applied to those unaffected by drought pressures. The prevalence of mental health problems in farm workers is, however, more nuanced. The percentage of *all* farm workers (i.e. those affected and unaffected by drought) with a mental

health problem was marginally higher than those in non-agricultural employment (9.1 and 8.9 per cent respectively). However, mental health problems were more common amongst farm workers than non-agricultural employees in drought affected areas (11.9 versus 9.4 per cent). The opposite was true amongst farm workers in unaffected areas when compared to non-farming counterparts (mental health problems were indicated in 5.5 per cent of farm workers in unaffected areas, compared to 8.5 per cent of non-farm workers). Average mental health wellbeing scores (average SF-36) mirrored these patterns.

In a study of the impact of rural and agricultural residence on the health, Merchant *et al.* [64] observed a lower prevalence of depression (indicative of a CES-D score of ≥8) amongst both female and male farm residents (19.8 and 15.4 per cent), when compared to their non-farm and town-dwelling counterparts (26.9 per cent amongst rural, non-farm women; 17.9 per cent amongst rural non-farm men; 28.3 per cent amongst town women; 18.3 per cent amongst town men). The percentage of male farmers being treated for depression from a doctor was lower than both rural, non-farm and town residents (8.6, 11.4 and 10.7 per cent respectively). Like farm men, farm women were less likely to have been treated by a doctor for depression than non-farm, rural counterparts (19.0 and 22.5 per cent, respectively), but were more likely to have done than women residing in the town, of which just 18.5 per cent reported having received treatment for depression. Whilst use of CES-D and self-reported treatment information contribute a range of data to the discussion, in this particular study, residence type was a poor indicator of involvement in farming at the time of the research (in fact, as many as 42.3 per cent of female farm residents were *not* actively involved in farming, and over a fifth of male town residents were).

Using the CIS-R to evaluate psychiatric status of 425 British farmers, farmworkers and family members, Thomas *et al.* [65] conclude that British farmers have lower levels of psychiatric morbidity than non-farmers (as per Office of Population Censuses and Survey

data, 1993). The authors observed how farmers had a lower absolute percentage of overall psychiatric morbidity (indicated by a CIS-R score of ≥12) when compared to non-farmers (5.9 versus 16.0 per cent, respectively), as well as a lower prevalence of 'moderate' and 'severe' depression (4.2 versus 10.1 per cent), and a lower prevalence of 'moderate' and 'severe' depressive ideas (5.4 versus 9.7 per cent). These patterns held true in adjusted[9] odds ratios, with the exception of farmers' odds of reporting depressive ideas which aligned with the non-farming cohort.

Work by Sanne *et al.* [66] offers little consensus about the comparative mental health status of farmers when exploring the level and prevalence depression and anxiety amongst Norwegian farmers aged 40-49. Specifically, mean (depression) HADS-D scores for full- and part-time, male and female farmers (aged 40-49) were significantly higher (worse) than non-farmers (full-time, male farmers: 4.72, part-time male farmers: 4.25, non-farming males: 3.38 and full-time, female farmers: 3.61, part-time female farmers: 3.35, non-farming females: 2.88). Similarly, the prevalence of cases of 'possible' depression (indicated by a HADS-D score of ≥8) was also significantly higher amongst male farmers than non-farming counterparts (full-time, male farmers: 19.1 per cent, part-time male farmers: 16.3 per cent, non-farming males: 9.3 per cent). Full-time female farmers in their study were significantly more likely to suffer 'possible' depression than their non-farming counterparts (14.3 per cent versus 7.3 per cent), and although part-time farmers had a higher prevalence (in terms of absolute percentages), when compared to female non-farmers, this difference was not statistically significant (10.1 per cent versus 7.3 per cent). Anxiety levels (mean HADS-A scores), however, were more nuanced. Whilst mean scores were higher for both full- and part-time male farmers when compared to non-farming males (4.80, 4.85 and 4.30 respectively – differences that were statistically significant), anxiety levels for full- and part-

[9] ORs were adjusted for sex, age, working status, longstanding illnesses, disability and infirmity

time female farmers did not differ significantly from their non-farming counterparts (although note, their absolute mean scores were higher than non-farming females: full-time: 4.86, part-time: 5.07, non-farming: 4.76). There were no significant differences in prevalence of 'possible' anxiety between farmers and non-farmers.

Drawing on results of the Norwegian HUNT2 survey (1995-1997), Torske *et al.* [76] found only marginal differences between farmers' mean HADS-A score (4.1) and the prevalence of caseness (13.8 per cent HADS-A ≥8) when compared to 'Higher grade professionals' (4.0 mean score; prevalence of caseness 13.6 per cent), 'Lower grade professionals' (4.0, 12.6 per cent), 'Routine non-manual workers' (4.2, 14.3 per cent), 'Self-employed' (4.4, 15.9 per cent), 'Skilled manual workers' (3.9, 11.9 per cent) and 'Unskilled manual workers' (4.3, 15.1 per cent) in the same study. However, the level and prevalence of depression amongst farmers emerged far more definitively; 'Farmers' (3.7 mean score, prevalence of caseness 11.6 per cent), 'Higher grade professionals' (2.9, 7.3 per cent), 'Lower grade professionals' (2.7, 5.6 per cent), 'Routine non-manual workers' (2.9, 6.5 per cent), 'Self-employed' (3.2, 7.8 per cent), 'Skilled manual workers' (3.1, 7.0 per cent) and 'Unskilled manual workers' (3.1, 8.0 per cent). Using a later iteration of the HUNT survey (2006-2008) Torske *et al.* [67]– partly reiterated that of Sanne *et al.*, showing higher mean HADS-D scores amongst farmers and a higher prevalence of depression caseness than the 'any other occupation' group; a difference that increased with age. When adjusting for both age this pattern held true (odds ratios for male farmers was 1.49 and 1.29 for females when compared to the 'any other occupation' group), but weakened when adjusting for age and educational attainment (falling to 1.35 for men and 1.21 for women). The authors note, the mean levels of depression found in the study were well below the cut-off for caseness (as would be anticipated amongst working participants), which (in a similar vein to Hounsome *et al.*, above), could indicate a 'considerable number of excess cases of depression' in the whole

population. However, unlike Sanne *et al.* – who observed comparatively higher levels of anxiety amongst males only and a similar prevalence of caseness amongst both male and female farmers– their anxiety results were more consistent, identifying no differences in the level, nor the prevalence of between farmers and non-farmers. Later work, also in Norway, by Letnes *et al.* [24] further supports the idea that Norwegian farmers are *more likely* to suffer from depression compared to those in 'any other occupations' (AOO). 13.1 per cent of farmers surveyed were suffering from symptoms of depression (indicated by a HADS-D score of ≥8) compared to just 8.4 per cent of those in AOO. Overall, farmers' HADS-D mean scores was also higher (3.9) than those in AOO (3.1).

Work by Wheeler *et al.* [68] also fails to reach a consensus regarding the rate of psychological distress amongst Australian farmers and irrigators. Based on their analysis of HILDA data, they suggest farmers (i) nationally and (ii) within the Murray-Darling basin had lower rates of 'high' and 'very high' psychological distress (indicated by K10 scores of 22-29 and 30-50) than their respective non-farming populations in the same time frame (2007-2013). According to their own primary data, however, horticulturalists and Broad-acre irrigators suffered higher rates of distress at the time of the survey (2015-2016) than the non-farming population during the Millennium Drought (2007-2013), whilst rates of distress were comparatively lower amongst dairy and livestock irrigators. Although useful in capturing the state of farmer and irrigator mental health, the value of the comparison to the non-farming population is limited by the use of data from different time periods.

Also concerned with drought-affected communities, Stain *et al.* [48] found farmers were less likely than non-farmers to be suffering psychological distress (indicated by a K10 score >15); 20.0 per cent of farmers scored K10 ≥16, compared with 24.5 per cent of non-farmers, *but* more likely than non-farming, farm residents (of which, just 12.6 per cent scored

≥16). Farmers' mean K10 scores muddy the waters further; not differing significantly between non-farmers and non-farming, farm residents (13.69, 13.15 and 14.44 respectively).

Unadjusted results of a recent study by Janzen *et al.* [14] demonstrated how non-farmers in rural Canada were actually more vulnerable to depression than their farming counterparts. Specifically, 11.3 per cent of farm women had been diagnosed with depression (responding positively to the question 'Has a doctor or primary care giver ever said you have depression?'), compared to 16.6 per cent of non-farm rural women, and the pattern was replicated for men, with 4.7 per cent of farmers compared to 7.2 per cent of non-farmers having being diagnosed with depression. However, this 'detrimental association' between non-farming status and depression *only* held true following the multivariable analysis in a small number of circumstances: (i) for non-farm women suffering two or more chronic conditions, and (ii) amongst non-farm men with a secondary school education, i.e. depression was just as prevalent amongst non-farmers outside of these sub-groups as it was farmers in rural Canada.

In a national French study [77] Cohidon *et al.* make comparisons between farmer mental health and other occupational groups using the CES-D. The study highlights a higher prevalence of depression amongst farmers (13.5 per cent), alongside 'Clerks, service and sales workers' (15.7 per cent), 'Self-employed, tradespeople, shopkeepers' (13.6), and 'Blue collar workers' (12.6 per cent), when compared to 'Associate professionals and technicians' and 'Managers' at 10.1 per cent and 7.8 per cent respectively. Female farmers had a higher prevalence of depression (10.4 per cent), alongside 'Clerks, service and sales workers' and 'Blue collar workers' (both 12.3 per cent), when compared to 'Associate professionals and technicians' (8.6 per cent), 'Managers' (7.6 per cent) and 'Self-employed, tradespeople, shopkeepers' (4 per cent). It is worth noting, the study uses different cut-offs for caseness for males and females (≥17 for men and ≥23 for women), and notes 'surprisingly' finding

'identical' prevalence of depression across males and females – something that they claim is unlikely to be accurate in reality. The difference in cut-offs also makes it difficult to compare the prevalence to other studies who have used a standardized level of CES-D cut-off.

In an assessment of Greek farmers, using the Montgomery-Asberg Depression Rating Scale (MADRS), Demos *et al.* [69] identified how, *overall*, 7.3 per cent of farmers in their sample (*n*=328) reported depression in their personal subjects' statements, compared to 9.5 per cent of non-farmers. More focussed analysis however, reveals the prevalence of "any grade of depression" was less prevalent in young farmers (those aged 35-39 and 40-49) than their non-farming counterparts. However, the pattern was reversed with respect of older farmers (those in age categories 50-59, 60-69 and 70 and over). Multivariate logistic regression analysis – used to calculate odds ratio (OR) – confirms this pattern for depression (amongst other morbidities); having controlled for demographic factors such as education, income and education. Work in the US [70] observed the SF-36 mental component summary score (which reflects limitations caused by emotional problems, vitality, social functioning, and mental health) also differed according to farmer age in their small sample of Illinois farmers (*n*=87). Therefore, unlike the trend observed by Demos *et al.* [69]'older' farmers (aged 65-74) were *less* vulnerable to poor mental health, with overall mental health scores akin to other, non-farming US citizens. Inversely, 'younger' farmers (aged 55-64) scored worse than similarly aged, non-farmers.

With specific reference to rural residents experiences of distress in New South Wales, Australia, Fragar *et al.* [82] observed average levels of distress/K10 score amongst 'Farmers and farm managers' (15.4) to be higher than 8 out of 9 of the other occupational groups listed ('Other managers' 13.9; 'Educational professionals' 15.2; 'Health professionals, health and welfare workers' 14.5; 'Other professionals' 14.9; 'Technicians and trades workers' 15.0; 'Clerical, administrative and sales workers' 14.7; 'Machinery operators, drivers and

labourers' 14.9; 'Occupation not specified' 14.7), but lower than 'Other community and personal service workers' (15.7), and lower than those not in employment and retired ('Student or carer' 16.1; 'Unemployed' 20.3; 'Permanently unable to work' 20.0; 'Retired' 13.6). The percentage of 'Farmers and farm managers' with moderate and high distress scores (34.2 per cent) was higher than all occupations ('Other managers' 24.9 per cent; 'Health professionals, health and welfare workers' 29.5 per cent; 'Other professionals' 28.0 per cent; 'Technicians and trades workers' 29.8 per cent; 'Clerical, administrative and sales workers' 32.7 per cent; 'Machinery operators, drivers and labourers' 31.2 per cent; 'Occupation not specified' 31.4 per cent), with the exception of 'Educational professionals' (34.3 per cent) and 'Other community and personal service workers' (35.8 per cent). Fragar *et al*. conclude that the "high levels of psychological distress *across* occupational groups are of serious concern" (p. 30, emphasis added), i.e. such distress is not exclusive to farming, and groups that are not in employment have important needs that are not being addressed.

In a large comparative study of farm and non-farm populations in rural New York state, Earle-Richardson *et al.* [83] found mixed results. When looking at the crude odds ratios for the whole farming sample (males and females), farmers had a *lower prevalence* of poor mental health days, depression and anxiety disorder than rural non-farmers (ORs: 0.92, 0.70, 0.60). This pattern held true for adjusted odds ratios (adjusted for age, college/no college, and has regular doctor or health care provider) with the exception of poor mental health days (for which farmers had a higher adjusted odds ratio of 1.08). Broken down by gender, according to adjusted odds ratios, poor mental health days and depression were *more prevalent* amongst male farmers than rural non-farmers (ORs: 1.77[10], 1.13 respectively), whilst anxiety disorders were less prevalent amongst male farmers (OR: 0.84). All three measures (poor mental health

[10] Described as "approached but did not reach statistical significance"

days, depression and anxiety disorders) were less prevalent amongst female farmers than their rural non-farming counterparts (ORs: 0.10, 0.54, 0.67 respectively).

Discussion

The overall lack of consensus offered from this review provides inconclusive evidence for the proposition that farmers are disproportionately impacted by mental health problems (see also Berry *et al.* [106] who echoes this sentiment). This lack of consensus sits in contrast to the weight of colloquial evidence supporting the idea of a farming mental health crisis [15-19], and the only other known attempt to synthesise the literature in the 'farmer versus non-farmer mental health' space [52]. Specifically, they observed how 71 per cent of reviewed articles (20/28) suggested farmers suffer *worse* mental health status than the general population (although their review included articles published between 1979-2019 and with reference to any country rather than just developed nations).

The most significant contrast however is between the lack of consensus regarding farmers' relative mental health status revealed and the comparative rate of farmer suicide, which emerges far more definitively in the literature[11] (see for example, [11,31-36,107-110]. The disparity between relative level and prevalence of psychological morbidity and suicide has been observed elsewhere; for example, work by Thomas *et al.* [65] initially appears to contradict the idea of a mental health crisis in agriculture (as reviewed above – farmers had a lower prevalence of psychological morbidity as per their *overall* CIS-R scores). However, the authors were surprised to observe that farmers in the study were two and a half times more likely to report thinking life was not worth living when compared to the British household population. Also, as above, retrospective cohort studies in both Australia, the US and the UK [61,73,74] observed how farmers who committed suicide were no more likely than non-

[11] Although Weichelt *et al.*, 2021 and Skegg *et al.*, 2011 provide seemingly anomalous exceptions

farming counterparts to have had a known mental health condition or received treatment/support prior to their death (although another retrospective cohort study [81] contradicts this). In a qualitative exploration of farmer suicide, Ramirez-Ferrero [111] also observed farmers who committed suicide were not always struggling with ill-health or depression. Letnes *et al.* [24] also hint at the skewed/seemingly contradictory relationship between depression and mortality; concluding how "symptoms of depression were associated with an increased mortality risk in farmers, but the risk increase was smaller compared with the other occupational groups" (p. 1), i.e. depression was less likely to result in death (albeit from any cause) amongst farmers, than amongst those in other occupations.

Taken altogether, we concur with Judd *et al.* [62], who – after finding no support for higher rates of mental illness among farmers (see above) – posit, "the elevated rate of suicide amongst farmers does not seem to be simply explained by an elevated rate of mental health problems" (p. 1). The incongruence of the mismatch between levels/prevalence of psychological morbidity and suicide rates within the farming community is significant, particularly when psychiatric disease is recognised as a key risk factor in suicides worldwide (Bachmann, 2018), and in some farming studies in the UK [112] Australia [22], New Zealand [113], USA [53,114,115], Switzerland [33] and Finland [116]. *So why does this mismatch exist in some studies? – and why does it matter?* It suggests the relationship between mental illness and suicide in the farming community is 'quite different' than in the wider population (as described by Thomas *et al.* [65]), and that psychological morbidity might – in some cases – be a poor correlate of suicidal ideation and suicide amongst farmers (see Bradvik, 2018 from Bjornestead *et al.* [53]). Judd *et al.* [62] attribute their "failure to find elevated rates of mental health problems" amongst farmers to "'farm-specific' factors" (p.8) (which they note is consistent with the findings of Thomas *et al.* [65]), including how farmers move 'very quickly' through the suicide process, exacerbated by a more functional attitude towards death

and access to the means e.g. firearms and toxic chemicals [39]. They also note the impact of social transmission of suicidal ideation, owing to the prevalence of suicide amongst colleagues. The role and intensity of farm-specific stressors, such as financial uncertainty/volatility, animal disease, extreme weather events and legislative/regulatory changes are also likely contributors to farmers' 'atypical' progression to suicide (although little work has explicitly demonstrated the role of farming-specific stressors in farmer suicide – Kunde et al. [117] providing a notable example).

The idea that farmers have a different relationship with, and progression to, suicide mirrors work on suicide pathways by Kunde *et al.* [117]. They document how the majority of farmers in their sample (78 per cent) progressed through an 'acute suicidal process' characterised by a lack of communication of intent or self-injurious behaviour to family and/or health professionals, and no long-term history of mental illness. Recent work by Bjornestad *et al.* further severs the apparent relationship between mental ill-health and suicide in the farming community and may explain the acute situational pathway proposed by Kunde *et al.* Using a linear regression model, 'coping through self-blame' emerged as the only variable to have a significant linear relationship with suicide risk (i.e. they found no significant relationship between depression and anxiety symptoms and suicide risk). According to Bjornestad *et al.* farmers experiencing characterological self-blame internalize their difficulties and resign themselves to the fact they cannot effect change, which they propose may be factors in the development and progression of suicidal thoughts and acute responses as observed by Kunde *et al.* The 'different pathway' suggests that, amongst farmers, suicide is not always the "extreme end of a continuum of psychological stress, distress and tragedy" (Boulanger *et al.*, quoted in Hounsome *et al.,* [21: 503]) but an acute response to stressors. On this basis, although counterintuitive, could it be that suicide (the visible part of the iceberg), might not be as closely associated with the state of mental health

in the farming community (i.e. what is going on 'below the surface') as it is in the broader community? Or is it that current methodological approaches are actually failing to gauge the mental health status of farmers (i.e. below the surface of suicide statistics)? – this is particularly pertinent given attitudes towards help-seeking amongst the farming community [63,118-120]. Could it be that – owing to the strength of agrarian values and specifically, masculine norms associated with farming (see Kunde et al., 2018) – farmers are less likely to declare or even admit mental health difficulties, even as part of anonymous research? The male dominated nature of farming – and the patriarchal nature of farming systems across developed nations – is also significant here, given that it is widely reported that men are less likely to disclose health problems on self-reported health indicators (the so called 'gender gap in self-reported health' [121]) and, inversely, males are more likely to over-report psychological wellbeing than women (Brown *et al.* [122], in relation to GHQ-12 reporting bias). Is it also plausible that, in some cases, farmers do not even recognise symptoms of deteriorating or poor mental health? Evidence shows how prior to suicide, a key difference between farmers and the wider population was that over 30 per cent of farmers in their study had presented at their GP surgeries with exclusively physical symptoms [61]. A similarly significant discrepancy was noted by Torske *et al.* [67] in that, despite measuring higher levels of depression amongst the farming cohort, farmers reported having the same quality of life as those in non-agricultural occupations, leading the authors to suggest a higher level of depression may not be perceived as a medical problem amongst farmers. Further evidence shows how farmers appeared "less likely to acknowledge their mental health issues when asked about specific symptoms" but are more likely to "recognise a poorer sense of well-being" [63: 9]. Similarly, in interviews with (male) farmers, Alston and Kent [123] observed farmers' tendency to frame mental illness symptoms as 'merely' stress, rather than anything more sinister. As such, depending on the methods used to determine psychological morbidity

it is possible that – owing to poor levels of 'mental health literacy' – symptoms might not be recognised (and therefore declared) as problematic.

Conclusions and recommendations

In response to a wealth of colloquial evidence (see also [124]), this paper set out to understand whether farmers are more vulnerable to psychological morbidity, relative to the wider, non-farming population. By synthesising studies across developed nations that explicitly compare farmer and non-farmer mental health outcomes, the paper has highlighted very little consensus. The nuanced picture sits in contrast to the consistently worrisome suicide statistics. The review speculatively attributes what it describes as a 'mismatch' to either (i) farmers' progression through a different 'pathway' to suicide that is not always preceded by mental illness, or (ii) a failure of current methods to accurately gauge mental health status across the agricultural community, owing to either farmers' difficulties admitting issues or failure to recognise symptoms of mental ill-health. Despite this lack of consensus, this review does not strive to conclude that mental ill-health is not a key challenge facing the agricultural industry across developed nations. Instead it highlights – as an academic community – we are failing to capture what is really going on 'beneath the surface'.

With this discrepancy in mind, we raise the following interrelated points intended as recommendations to inform next steps in this important research area. Firstly, we caution against using levels of psychological morbidity as a predictor of suicide in the farming community. Secondly – and closely linked to the first point – using rates of mental ill-health (based on existing methods and measures) as a gauge of the relative mental state of farmers may not give the fullest, most accurate picture. Particularly where comparisons are methodologically inequitable (e.g. comparing data from different timeframes, locations or based on different methods of mental health assessment). Thirdly, further research is needed to better understand the relationship between psychological morbidity and suicide in the

farming community, as this review has pointed to the existence of a 'different' relationship than exists in the non-farming community. To use Lobley and colleague's [11,13] useful analogy, this will enable us to better understand what is going on below the visible part of the iceberg' and will thus inform more targeted and effective intervention. Lastly, researchers – from a range of disciplines – need to come together as part of a dedicated programme of methods research, in order to research and subsequently design appropriate, sensitive and accurate methodological options for capturing farmers' experiences of psychological morbidity, before further empirical endeavours on the state of the problem are conducted. As Hagen et al. note, there are currently no methodological guidelines for measuring individual mental health outcomes in the farming population; a gap that must be addressed. This is likely to involve more in-depth, qualitative methods that are capable of being sensitive to the impact of farming's normative structures on perceptions and causes of mental ill-health, including the influences of the patriarchal family farm structure [41] and rural masculine ideals [125-128], such as the 'biopsycho-ecological approach' [129], and may include utilising those already embedded into farming communities to support/deliver research (see [130]) who interviewed agri-business personnel to gain insight into the mental health status of farmers). Where quantitative approaches are used it will be important to use *standardized* approaches that allow for comparison of results across space and time (see 127 – a study by The Royal Agricultural Benevolent Institution for a recent, best practice example of a large study) – something the suite of approaches documented in this review does not currently offer. Mental health literacy training amongst farmers and the wider farming community may also reduce the stigma associated with mental health issues and increase the accuracy of self-administered reporting, too. As farmers face the multiple effects of Covid-19 [132], manage and help mitigate the impacts of climate change, and negotiate legislative reform (particularly in the case of EU-exit), we are reminded of their vulnerability and simultaneous importance

as food producers and guardians of land; a new approach to understanding farmer mental health is perhaps now, more pertinent than ever.

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Supplementary Information

Box 1: Search terms used

Web of Science search (AB=((depression* OR "clinical depression" OR "depressive disorder" OR anxiety* OR suicide* OR "mental health" OR "mental disorder" OR "mental illness" OR schizophrenia* OR "suicidal ideation" OR stress*))) AND AB=((farmers OR "farm families" OR farming))
PubMed Pub med (depression*[Title/Abstract] OR "clinical depression"[Title/Abstract] OR "depressive disorder"[Title/Abstract] OR anxiety*[Title/Abstract] OR suicide*[Title/Abstract] OR "mental health"[Title/Abstract] OR "mental disorder"[Title/Abstract] OR "mental illness"[Title/Abstract] OR schizophrenia*[Title/Abstract] OR "suicidal ideation"[Title/Abstract] OR stress*[Title/Abstract]) AND (farmers[Title/Abstract] OR "farm families"[Title/Abstract] OR farming[Title/Abstract])
ProQuest (ab((depression* OR "clinical depression" OR "depressive disorder" OR anxiety* OR suicide* OR "mental health" OR "mental disorder" OR "mental illness" OR schizophrenia* OR "suicidal ideation" OR stress*)) AND ab((farmers OR "farm families" OR farming)) AND stype.exact("Scholarly Journals")
APA PsycArticles (Abstract: depress* OR Abstract: "clinical depression" OR Abstract: "depressive disorder" OR Abstract: anxi* OR Abstract: suicid* OR Abstract: "mental health" OR Abstract: "mental disorder" OR Abstract: "mental illness" OR Abstract: schizophren* OR Abstract: "suicidal ideation" OR Abstract: stress*) AND (Abstract: farm* OR Abstract: "farm families") AND Year: 1999 To 2021

Table 1: Summary of literature

Author & year of publication	**Country**	**Time of data collection**	**Target population**	**Measure of psychological morbidity** (see Box 2)	**Condition and criteria**	**Farmers' mental comparative mental health**			**Source of comparison to non-farmers**	**Key limitations**	**Total quality score** (see criteria in Table 1 & 2)
						Better B	Same S	Worse W			
Hounsome *et al.* (2012) [21]	UK	2002 – 2004	Farmers and their spouses (over three years of the study) ***n*=287**	GHQ-12	Mean (psychological distress) score			W	Comparison to non-farming agricultural show attendees	• Small sample size – too small to generate sufficient statistical power for sub-group analysis • Difference in mean GHQ-12 scores is unlikely to be indicative of clinically significant differences between populations (commonly accepted cut-off score of 11-12 for psychiatric disorders). • Results are a product of an unavoidably biased sample of farmers well enough to attend agricultural shows, i.e. the true level of psychiatric morbidity may have been underestimated by the study.	4 (High)
					Prevalence of cases of psychiatric disorders (% with GHQ-12 ≥12)			W			
Thomas *et al.* (2003) [65]	UK	March – July 1999	Farmers, farmworkers and family members ***n*=425**	CIS-R	*Overall* psychological morbidity: absolute % of farmers with CIS-R score ≥12	B			Comparison to UK household population (OPCS) 1993 using the same measure (CIS-R)	• Farm survey was conducted six years after the OPCS UK household survey.	3 (Medium)
					• CIS-R sub-section: absolute % with 'moderate' or 'severe' depression	B					
					• CIS-R sub-section: absolute % with 'moderate' or 'severe' depressive ideas	B					

					Adjusted odds ratio[12] for *overall* psychological morbidity (CIS-R score ≥12)	B					
					• CIS-R sub-section: adjusted odds ratio[1] for 'moderate' or 'severe' depression	B					
					• CIS-R sub-section: adjusted odds ratio for 'moderate' or 'severe' depressive ideas		S				
Judd *et al.* (2006) [62]	Australia	-	Farmers (anyone living / working on a farm and whose main source of income came from the farm; did not include retired farmers or spouses / partners) ***n*=371**	K10	Mean K10 (level of psychological distress) score	B			Comparison to 380 non-farmers in the same study	• Quantitative sample were a self-selected group (drawn from participants who had agreed to be contacted for the project).	4 (High)
					Logistic regression analysis: Binary K10 – Step 1 (where farmer status was the sole predictor)		S				
				PANAS (NA)	Mean (NA) score		S				
				PANAS (PA)	Mean (PA) score	B					
					Logistic regression analysis: Binary PA – Step 1 (where farmer status was the sole predictor)	B					
					Logistic regression analysis: Step 2 (where both farmer status & demographic / personality variables were entered)		S				
				SF-12-MCS	Mean (MCS) score	B					
					Logistic regression analysis: Binary MCS – Step 1 (where farmer status was the sole predictor)	B					
					Logistic regression analysis: Step 2 (where both farmer status & demographic / personality variables were entered)		S				
Sanne *et al.* (2004) [66]	Norway	1997-1999	Full-time male farmers aged 40-49 ***n*=204**	HADS-A	Mean HADS-A (anxiety) score			W	Compared to 16,378 non-farm workers from the same study (Hordaland Health Study)	• Narrow age range surveyed (40-49) reduces the generalizaibility of the findings. • Moderate participation rate; information acquired	4 (High)
					Prevalence of 'possible' cases of anxiety (% with HADS-A ≥8)		S				
			Full-time female farmers aged 40-49 ***n*=126**		Mean HADS-A (anxiety) score			W			
					Prevalence of 'possible' cases of anxiety (%with HADS-A ≥8)		S				

[12] Adjusting for gender, age, working status, longstanding illness, disability and infirmity

			Part-time male farmers aged 40-49 ***n*=369**		Mean HADS-D (depression) score			W		through self-administered questionnaires. • HADS does not provide a definitive diagnosis of anxiety and depression disorder. • Impact of 'Healthy Worker Effect' is likely to have biased the sample.	
					Prevalence of 'possible' cases of depression (% with HADS-D ≥8)		S				
			Part-time female farmers (full- and part-time) aged 40-49 ***n*=218**		Mean HADS-D (depression) score			W			
					Prevalence of 'possible' cases of depression (%with HADS-D ≥8)		S				
			Full-time male farmers aged 40-49 ***n*=204**	HADS-D	Mean HADS-D (depression) score			W			
					Prevalence of 'possible' cases of depression (% with HADS-D ≥8)			W			
			Full-time female farmers aged 40-49 ***n*=126**		Mean HADS-D (depression) score			W			
					Prevalence of 'possible' cases of depression (%with HADS-D ≥8)			W			
			Part-time male farmers aged 40-49 ***n*=369**		Mean HADS-D (depression) score			W			
					Prevalence of 'possible' cases of depression (% with HADS-D ≥8)			W			
			Part-time female farmers (full- and part-time) aged 40-49 ***n*=218**		Mean HADS-D (depression) score			W			
					Prevalence of 'possible' cases of depression (%with HADS-D ≥8)			W			
Torske *et al.* (2016) [67]	Norway	2006-2008	Male farmers ***n*=1,100**	HADS-A	Mean HADS-A (anxiety) score		S		Compared to 'all other occupations' (in the same study)	• Study relies on self-reported data; does not distinguish between full- and part-time farmers, including whether farmers had any other jobs outside farming.	4 (High)
					Prevalence of 'probable' cases of anxiety (% with HADS-A ≥8)		S				
			Female farmers ***n*=317**		Mean HADS-A (anxiety) score		S				
					Prevalence of 'probable' cases of anxiety (% with HADS-A ≥8)		S				
			Male farmers ***n*=1,100**	HADS-D	Mean HADS-D (depression) score			W			
					Prevalence of 'probable' cases of depression (absolute % with HADS-D ≥8)			W			
					Odds ratio (adjusted for age) for 'probable' cases of depression (HADS-D ≥8)			W			
					Odds ratio (adjusted for age and education) for 'probable' cases of depression (HADS-D ≥8)			W			
			Female farmers ***n*=317**		Mean HADS-D (depression) score			W			
					Prevalence of 'probable' cases of depression (absolute % with HADS-D ≥8)			W			

					Odds ratio (adjusted for age) for 'probable' cases of depression (HADS-D ≥8)			W			
					Odds ratio (adjusted for age and education) for 'probable' cases of depression (HADS-D ≥8)			W			
Torkse et al. (2015) [76]	Norway	1995-1997 & follow-up in 2010	Farmers aged 20-69 at the time of the 1995-1997 study ***n*=3495**	HADS-A	Mean HADS-A (anxiety) score[13]		S		Higher grade professionals	• HADS is not a clinical diagnosis of depression or anxiety (scores can increase transiently in response to physical illness etc.).	4 (High)
							S		Lower grade professionals		
							S		Routine non-manual workers		
							S		Self-employed		
							S		Skilled manual workers		
							S		Unskilled manual workers		
					Prevalence of 'probable' cases of anxiety (% with HADS-A ≥8)[14]		S		Higher grade professionals		
							S		Lower grade professionals		
							S		Routine non-manual workers		
							S		Self-employed		
							S		Skilled manual workers		
							S		Unskilled manual workers		
					Mean HADS-D (depression) score			W	Higher grade professionals		
								W	Lower grade professionals		
								W	Routine non-manual workers		
								W	Self-employed		
								W	Skilled manual workers		

[13] Maximum difference between farmer and other occupations was 0.3 and Torkse *et al.* do not mention HADS-A mean scores as being significantly different – as such they have been categorised as 'the same'

[14] Maximum difference between farmer and other occupations was 2.1 per cent and Torkse *et al.* do not mention the prevalence of HADS-A caseness as being significantly different – as such they have been categorised as 'the same'

								W	Unskilled manual workers		
					Prevalence of 'probable' cases of depression (absolute % with HADS-D ≥8)			W	Higher grade professionals		
								W	Lower grade professionals		
								W	Routine non-manual workers		
								W	Self-employed		
								W	Skilled manual workers		
								W	Unskilled manual workers		
Logstein (2016) [59]	Norway	2012	Single principal owner operators ***n*=2,676**	SCL-5	Prevalence of 'high symptom load of mental complaints' (includes both depression & anxiety) (% with SCL-5 of ≥2.0)		S		Compared to the Norwegian population in 1998 using the same scale (SCL) [104]	• Uses the SCL-5 scale to assess the total load of *both* anxiety and depression symptoms. By the authors' own admission "the findings in this study may be somewhat different when using other measures of mental health or if symptoms of anxiety and depression were treated as two separate scales" (p.324). • Comparison to general population mental health status uses data collected in a 1998 study (Strand, 2003), i.e. not a 'real time' comparison.	3 (Medium)
Logstein (2021) [43]	Norway	2012	(Exclusively) dairy farmers ***n*=492** (sub-sample of 2,676 farmers in Logstein *et al.*, 2016)	SCL-5	Mean 'mental complaints' (combines depression & anxiety) SCL-5 score		S		Compared to the Norwegian population in 1998 using the same scale (SCL) [104]	• Uses the SCL-5 scale to assess the total load of *both* anxiety and depression symptoms. See Logstein *et al.*, 2016, above.	3 (Medium)

			(Exclusively) vegetable/potato farmers ***n*=122** (sub-sample of 2,676 farmers in Logstein *et al.*, 2016)				S			• Comparison to general population mental health status uses data collected in a 1998 study (Strand, 2003), i.e. not a 'real time' comparison. • The inclusion of farm operations relating mainly to dairy or vegetables/potatoes is – by the author's admission a key limitation of the study. It is likely that participating farmers were those most likely to have contracts with cooperatives or retail chains, and thus the most 'successful' farmers.	
Brew *et al.* (2016) [28]	Australia	From 2007 onwards - 5-year longitudinal study	Regional farmers/farm workers	Self-reported mental health score	Mean mental health score		S		Compared to <u>regional</u> non-farm workers (in the same study)	• Loss of sample over the study time (5 years); potential to have caused selection bias, particularly if those that left the study withdrew owing to mental health difficulties.	4 (High)
			Remote or very remote farmers/farm workers					W	Compared to <u>remote</u> non-farm workers (in the same study)		
			All farmers/farm workers ***n*=181**[15]					W	Compared rural non-farm workers (in the same study)		
				K10	Estimated marginal mean (psychological distress) score		S				
				PHQ-9	Estimated marginal mean PHQ-9 (depression) score		S				
				Service use	% reported seeing a mental health professional in the last 12 months	B					
Demos *et al.* (2013) [69]	Greece	2008-2009	All farmers aged ***n*=328**	Depression	% reporting depression in the 'subjects' statement' of morbidities	B			Compared to randomly selected, non-farmers in the same communities, in matched age categories as part of	• Cross-sectional study – observational and descriptive in nature (not able to draw any causal inferences).	4 (High)
			Farmers aged 35-39 'young farmers' ***n*=61**	MADRS	% with "any grade of depression" (MADRS score >6)	B					

[15] *n*=181 at 'baseline', reducing to n=108, n=68 and n=67 at the 1st, 3rd and 5th year surveys, respectively

			Farmers aged 40-49 'young farmers' ***n*=84**			B			the same study (total *n*=347)	• Potential misclassification of self-reported morbidities. • Potential 'healthy worker effect' bias by comparing to non-farmers.	
			Farmers aged 50-59 'older farmers' ***n*=90**					W			
			Farmers aged 60-69 'older farmers' ***n*=60**					W			
			Farmers aged 70 and over 'older farmers' ***n*=33**					W			
Harrison and Ross (2016) [72]	UK	-	UK sheep farmers aged between 18 and 70 years old exposed to OP pesticides for a minimum of 5 years prior to 1991 but not requiring medical intervention, i.e. 'low-level' exposure, also includes those who had retired on ill-health grounds (to counter 'healthy worker effect') ***n*=127**	HADS-A & BAI	Mean HADS-A & BAI (anxiety) scores			W	Compared to non-farming control group in the same study (*n*=78) (unexposed to pesticides) of rural police workers / retirees (matched in terms of gender, education level of intelligence, working status and area of residence)	• No single, agreed definition of 'acute' or 'low-level' exposure to OPs may skew results; i.e. it is possible that the study inadvertently included participants with undiagnosed acute toxicity thus *overestimating* the association between exposure and ill-health. • Removal of more than 60% of respondents due to strict exclusion criteria may mean *underestimation* of the risk associated with exposure to OPs. • Reliance on participant memory about exposure over their entire farming career; vulnerable to errors in memory.	4 (High)
				HADS-D & BDI	Mean HADS-D & BDI (depression) scores			W			
				SCID	Anxiety diagnosis (cases)			W			
					Depression diagnosis (cases)		S				
Letnes *et al.* (2016) [24]	Norway	1995-1997	Farmers aged 20 and over, includes those currently employed and formerly employed in farming ***n*=3,962**	HADS-D	Probable cases of depression (HADS-D ≥8) (absolute % of farmers)			W	Compared to 'any other occupation', 'Professionals', 'Routine manual workers', 'Self-employed workers' and 'Manual workers' (in the same study)	• Authors recognise the impact of non-response bias. • Use of self-reported assessments of baseline variables (including depression) is considered a weakness. • Participants with multiple occupations were categorised as the	4 (High)
					HADS-D mean score			W			

										occupation with the highest socioeconomic position within the Erikson, Goldthorpe and Portocarero (EGP) scale/classification. The authors felt "an alternative and probably better approach" might have been to classify them according to their dominant occupation (p.8). • HADS is a screening tool for symptoms and not a diagnostic tool. • HADS only asks about symptoms in the previous week.	
Booth and Lloyd (1999) [55]	UK	1995	'Whole-time principal farmers and partners' ***n*=312**	GHQ-28(-General)	Prevalence of cases of a clinically significant mental health problem (% with GHQ score >5)			W	Compared to the prevalence of GHQ score >5 in (1) the South West Region as a whole and (2) England, Wales and Scotland measured as part of the 1984-1985 Health and Lifestyle Survey [88]	• Low response rate (the authors suggest that this is likely to mean the level of psychiatric morbidity amongst the farming community is likely to have been *underestimated* in their study). • Compares farmer survey data from 1995 to general population from a different time frame.	3 (Medium)
					Mean GHQ score (psychological distress) scores			W	Compared to Devon and Cornwall mean GHQ scores measured as part of the 1984-1985 Health and Lifestyle Survey which [89]		
McLaren and Challis (2009) [22]	Australia	-	Male farmers aged over 18 who were currently farming in Northern Victoria or	Zung Depression Scale	Mean Zung Depression score			W	Compared to the Zung Depression scores of a group of randomly selected Australian men from rural areas	• Reliance on self-reported measures. • One-third of farmers who accepted the questionnaire did not return it;	3 (Medium)

			Southern New South Wales						(from a study published by the author in 2001 [99])	• "impossible to know how non-completers differed from completers, but it is possible that non-completers were more likely to have suicidal ideation, depressive symptoms, little social support and lessened sense of belonging" (p.273). • Unsure whether data used to compare farmers and non-farmers was at a similar point in time (studies published ~8 years apart).	
Peck *et al.* (2002) [37]	UK	January – February 2002	Farmers ***n*=198**	GHQ-12(-General)	Prevalence of cases of a clinically significant mental health problem (% with GHQ-12 score ≥4)			W	Compared to 1-week prevalence rate of neurotic disorder in the UK for males only, based on a different measure of caseness CIS-R [92]	• Data collected in the immediate aftermath of foot-and-mouth disease; wider representativeness of findings. • UK-wide data used for the comparison related to males only and was based on a different measure of caseness (CIS-R).	2 (Medium)
Booth *et al.* (2000) [61]	UK	1979-1994	Male members of the farming community (using standard occupation classifications) ***n*=63**	Current inpatient or day patient	% answering 'Yes'		S		Controls (and subjects) taken from a database of (662) deaths where suicide or open verdict had been recorded on residents, aged 16 or over, of the (former) Exeter Health District between 1979 and 1994.	• Considerable data missing owing to GP records being destroyed soon after patient death; percentages and statistical evaluation is adjusted accordingly.	2 (Medium)
				Previous inpatient			S				
				Outpatient or Community Mental Health Team client			S				
				Presence of a psychiatric diagnosis			S				
				Taking anti-depressants			S				

Guillien *et al.* (2018) [60]	France	2011-2015	Dairy farmers with 'normal spirometry' (i.e. those without COPD) ***n*=98**	HADS-D	Prevalence of 'possible/probable' cases of depression (% with HADS-D ≥8)		S		Non-farmers with 'normal spirometry' (i.e. those without COPD) in the same study	• Authors suggest it is "difficult to characterize anxiety and depression by a single score" i.e. HADS and suggest "it might have been appropriate to use other scores in addition to the HADS" (p.7)	4 (High)
			Dairy farmers with COPD ***n*=100**				S		Non-farmers with COPD as part of the same study		
			Dairy farmers with 'normal spirometry' (i.e. those without COPD) ***n*=89**	HADS-A	Prevalence of 'possible/probable' cases of anxiety (% with HADS-A ≥8)		S		Non-farmers with 'normal spirometry' (i.e. those without COPD) in the same study		
			Dairy farmers with COPD ***n*=85**				S		Non-farmers with COPD as part of the same study		
Jones-Bitton *et al.* (2020) [23]	Canada	September 2015 – February 2016	Male farmers (aged over 18 identified as a farmer, from any Canadian agricultural commodity group) ***n*=677**	HADS-A	Prevalence of 'probable' clinically significant cases of anxiety (% with HADS-A ≥11)			W	Compared to HADS data on non-farming population in the UK based on data collected in 2001/02 [87]	• Severe anxiety may have been over-represented in the sample. • Low response rate from those experiencing poor mental health, which would underestimate the prevalence of mental illness. • Broad sampling structure means the results are not proportional to commodity structure of Canadian agriculture. • Comparison to non-farmer levels of anxiety and depression uses an overseas (UK) study.	2 (Medium)
			Females (aged over 18, identified as a farmer, from any Canadian agricultural commodity group) ***n*=297**					W			
			Males (aged over 18 identified as a farmer, from any Canadian agricultural commodity group) ***n*=677**	HADS-D	Prevalence of 'probable' clinically significant cases of depression (% with HADS-D ≥11)			W			
			Females (aged over 18 identified as a farmer, from any					W			

			Canadian agricultural commodity group) ***n*=297**								
Rudolphi *et al.* (2020) [20]	USA	February – March 2018	Farmers & ranchers, aged 18-37 years old for whom farming and/or ranching is a primary occupation ***n*=170**	GAD-7	Prevalence of Generalized Anxiety Disorder (% with GAD-7 ≥5, i.e. 'mild' to 'severe' anxiety)			W	Compared to 12-month prevalence of 'any anxiety disorder' amongst the adult US population; collected between February 2001 and April 2003 using the National Comorbidity Survey Replication data (citing National Institute of Mental Health) i.e. not comparing 'like-for-like'	• Limited sample size. • Selection bias, i.e. possible that those with mental health concerns were more likely to respond than otherwise healthy individuals.	2 (Medium)
				PHQ-9	Prevalence of depressive disorder (% with PHQ-9 ≥5 i.e. 'mild' to 'severe' depression)			W	Compared to 12-month prevalence of 'major depressive disorder' amongst the adult US population; collected between February 2001 and April 2003 using the National Comorbidity Survey Replication data (citing National Institute of Mental Health) i.e. not comparing 'like-for-like'		
Syson-Nibbs *et al.* (2006) [71]	UK	May 2002	Primary farmers (those for whom farming was their sole occupation) ***n*=119**	HADS-D	Prevalence of 'clinical cases' of depression (% with HADS-D ≥11)			W	Compared to UK general population (also used HADS and same definition of 'caseness', i.e. ≥11) [91]	• Findings may only be generalizable to other UK hill farming communities.	4 (High)

								W	Compared to non-farmer sample from the same GP practice		
			Secondary farmers (those who were farmers with additional employment) ***n*=75**			B					
			Primary farmers (those for whom farming was their sole occupation) ***n*=119**	HADS-A	Prevalence of 'clinical cases' of anxiety (% with HADS-A ≥11)		S				
			Secondary farmers (those who were farmers with additional employment) ***n*=75**				S				
Janzen *et al.* (2020) [14]	Canada	2014	Male (location of residence: 'farm') aged 18 or over ***n*=906**	Measured by the question 'Has a doctor or primary care giver ever said you have depression?' (yes /no)	Prevalence of depression (absolute % answering 'yes')	B			Compared to rural residents in the same study	• Reliance on self-reported measures which "due to social desirability, may have resulted in depression […] being underreported" (p. 9). • Depression measure based on a single item and required contact with a medical professional. The 'healthy worker effect' is a possible explanation of lower levels of depression in farming males and females.	3 (Medium)
			Women (location of residence: 'farm') aged 18 or over ***n*=813**			B					
			Male (location of residence: 'farm') aged 18 or over ***n*=906**		(adjusted) odds ratio for depression diagnosis (i.e. those who answered 'yes')		(S[16])		Compared to non-farming rural residents in the same study		
			Women (location of residence: 'farm') aged 18 or over ***n*=813**				(S[17])				
Rayens *et al.* (2014) [37]	USA	-	Older farming husbands ***n*=494** aged >50 and living on a farm (as defined	20-item Centre for Epidemiologic Studies-	Prevalence of 'mild', 'moderate' and 'severe' depression (% where CES-D score ≥16)	B			Compared to other studies of aging populations in the USA:	• Purposeful sampling in only two southern states; not representative.	2 (Medium)

[16] Farm/non-farm residence was *only* associated with depression for men in one sub-group: non-farm men with secondary school education only
[17] Farm/non-farm residence was *only* associated with depression for women in one sub-group; non-farm women suffering two or more chronic conditions only

			by the Census of Agriculture i.e. potential for $1,000 or more agricultural income)	Depression (CES-D)					1. United States Department of Health and Human Services [134] 2. Shim *et al.* [135] analysed a sample from 2005-2008 and used a different measure of caseness – PHQ-9.	• Excluded unmarried farmers and farmers whose spouses did not participate; this may have resulted in a more homogenous sample than the entire group of older farmers. • Mean age of sample is older than that of the general farm principal operator. • One of the national datasets used for comparison (Shim *et al.*, 2011) used a different measure of caseness (PHQ-9), defines 'older' different (≥55). • The 'healthy worker effect' is a possible explanation of lower levels of depression observed in the farming sample.	
			Older farming wives ***n*=494** aged >50 and living on a farm (as defined by the Census of Agriculture i.e. potential for $1,000 or more agricultural income)			B					
Crimes and Enticott (2019) [5]	UK (Wales)	May/June 2013	Farmers (sampled from the Animal and Plant Health Agency's bTB database) ***n*=582**	Office of National Statistics (ONS) Subjective Wellbeing score	Mean Subjective Well-Being score (0-10)			W	Farmers' perceived SWB was lower than for the general population in the UK and Wales as per ONS (2013) 'Annual Population Survey' 2012/2013 [136]	• Low number of young farmers in sample.	4 (High)
Eisner, Neal and Scaife (1999) [56]	UK	1994 & 1996	Male farmers aged between 26-65 (either owner or tenant of a farm) in 1994 ***n*=106**	HADS (combined to indicate either anxiety or depression)	Anxiety or depression – combined into one 'positive result' (HADS ≥8; 'patient suffering from condition')			W	Compared to age and gender matched, in current employment unrelated to agriculture (in 1994) *n*=93 (as part of the same study)	• Limited sample size. • Geographical focus in one area only.	4 (High)
			Male farmers aged between 26-65 (either owner or tenant of a farm) in 1996 ***n*=106**					W	Compared to age and gender matched, in current employment unrelated to agriculture (in 1996)		

									n=93 (as part of the same study)		
Stain *et al.* (2008) [48]	Australia	-	Farmers and farm workers (work on a farm and may or may not live on a farm) ***n*=85**	K10	Prevalence of 'high levels' of distress (% of sample with K10 of ≥16)	B			Non-farmers (does not live nor work on a farm) – from the same study	• Low response rate. • An "inherent recruitment bias towards a sample that was more likely to be female, married and engaged in employment or other duties, compared to the overall adult population in the selected regions" (p.848).	4 (High)
								W	Farm residents (lives on a farm but does not work on a farm) – from the same study		
					Mean K10 (level of psychological distress) score		S		Non-farmers (does not live nor work on a farm) – from the same study		
							S		Farm residents (lives on a farm but does not work on a farm) – from the same study		
Edwards *et al.* (2015) [8]	Australia	2007	<u>All farmers</u> (in areas affected *and* unaffected by drought)	SF-36	% of farmers with a SF-36 score <52; i.e. % that 'satisfy the clinical diagnostic criteria for depression and related disorders'			W	Compared with those in non-agricultural employment as part of same study	• Those that had been most impacted by drought are likely to have moved out of the area; as such the authors suggest this is likely to have resulted in an underestimation of mental health impacts amongst the drought-affected cohort.	4 (High)
			• <u>Farmers</u> in areas affected					(W)			
			• <u>Farmers</u> in areas unaffected					(W)			
			<u>All farm workers</u> in areas affected *and* unaffected by drought					W[18]			
			• <u>Farmer workers</u> in areas affected					(W)			
			• <u>Farmer workers</u> in areas unaffected			(B)					

[18] Although this percentage difference was very small (<1 per cent) it has been categorised according to the absolute difference in percentage – please see narrative for a breakdown of the exact figures

			All farmers in areas affected *and* unaffected by drought		Average SF-36 score			W			
			• Farmers in areas affected					(W)			
			• Farmers in areas unaffected					(W)			
			All farm workers in areas affected *and* unaffected by drought					W			
			• Farmer workers in areas affected					(W)			
			• Farmer workers in areas unaffected			(B[19])					
Gunn *et al.* (2012) [40]	Australia	April – July 2008	Farmers and their spouses (aged 23-85) ***n*=309**	K10	Levels of distress (undefined)			W	Compared to the Australian population as per the National Health Survey (using K10) undertaken in 1997 [101]	• Low response rate. • Reliance on self-reporting measures to measure psychological distress is likely to have resulted in underreporting (although the authors note that anonymity offered to participants is likely to have mitigated the social desirability effect).	3 (Medium)
					% suffering 'high levels' of distress (undefined)			W	Compared to the broader rural population as per data collected (using K10) in 2004, 2005 & 2006 [100]		
Carruth and Logan (2002) [54]	USA	Summer 1998	Farm women (i.e. whose family participated in a farm operation) aged 18 years old or older ***n*=657**	Self-reported experience of depression (past 12 months)	Prevalence (%) of depression			W	Compared to National Health Survey (which used a different measure of caseness – CES-D) for the general population collected in 1974/75 [86]	• Reliance on self-reporting measures. • Limited generalizability beyond farm women in south Louisiana. • Uses outdated national data (from 1974/1975) as a comparison.	1 (Low)

[19] Although the difference in mean SF-36 score was very small (<1 'point' difference) it has been categorised according to the absolute difference in score – please see narrative for a breakdown of the exact figures

										• Comparison to wider population was based on a different measure of caseness (CES-D) and data was collected during a different timeframe.	
Stallones and Beseler (2002) [26]	USA	1992-1997	Male farm residents, operators and spouses ***n*=460**	20-item Centre for Epidemiologic Studies-Depression (CES-D)	Prevalence of depression (% where CES-D score ≥16)	B			Compared to the 12-month rate of 'major depressive episodes' (as per DSM-III-R definition) amongst the US population between 1990-1992 from the National Comorbidity Survey (NCS) [105]	• Difficult to generalize beyond geographical context (north eastern Colorado) "where farmers have not experienced many of the economic hardships that have plagued other areas of the country" (p.393). • Differences between farmer and general population data may be skewed, owing to: (i) the 'healthy worker effect', since the farmers in the sample are actively involved in work and therefore healthier than the wider population; (ii) and, the fact severely depressed farmers may have left farming. • US population data used for the comparison was based on a different measure of caseness (namely DSM-III-R, based on the Composite International Diagnostic Interview) and data was collected during a different timeframe.	2 (Medium)
			Female farm residents, operators and spouses ***n*=301**			B					

Stallones and Beseler (2004) [78]	USA	1993-1997	Farm operators and their spouses *n*=710	20-item Centre for Epidemiologic Studies-Depression (CES-D)	Prevalence of depression (% where CES-D score ≥16)	B			Compared to the 12-month rate of 'major depressive episodes' (as per DSM-III-R) amongst the US population between 1990-1992 from the National Comorbidity Survey (NCS) [105]	• US population data used for the comparison was based on a different measure of caseness (namely DSM-III-R, based on the Composite International Diagnostic Interview) and data was collected during a different timeframe.	2 (Medium)
Stiernstrom *et al.* (2001) [29]	Sweden	1989-1996	Male farmers born between 1930 and 1949 who worked a minimum of 25 hours a week (registered on the Swedish National Farm register) ***n*=1220**	Death or admission to hospital owing to 'mental disease' (as defined by International Classification of Diseases 9th edition)	Risk ratio	B			Compared to rural referents in the same study (*n*=1,130)	• Study population was relatively young at the time of data collection and the follow-up time short; differences may have not yet emerged within the study time frame.	4 (High)
						B			Compared to urban referents in the same study (*n*=1,087)		
				Number of hospital admissions owing to 'mental disease' (as defined by International Classification of Diseases 9th edition)	Mean number of hospital admissions per 10,000-person years (between 1989-1996)	B			Compared to rural referents in the same study (*n*=1,130)		
						B			Compared to urban referents in the same study (*n*=1,087)		
Thelin *et al.* (2009) [28]	Sweden	1989-2001	Male farmers born between 1930 and 1949 who worked a minimum of 25 hours a week (registered on the Swedish National Farm register) ***n*=1220**	Fatalities owing to psychiatric disorders (as defined by International Classification of Diseases 9th	Rate (deaths per 10,000 between 1989-2001)	B			Compared to rural referents in the same study (*n*=1,130)	• Difficulty in generalizing Swedish data from this time period to other contexts and timeframes.	4 (High)
						B			Compared to urban referents in the same study (*n*=1,087)		
					Hazard ratio	B			Compared to rural referents in the same study (*n*=1,130)		
						B			Compared to urban referents in the same study (*n*=1,087)		

				& 10th editions[20])							
				Morbidity owing to psychiatric disorders (as defined by International Classification of Diseases 9th & 10th editions[21])	Morbidity rate (number of deaths per 1,000 who died between 1989-2001 or were admitted to hospital between 1990-2002)	B			Compared to rural referents in the same study (*n*=1,130)		
						B			Compared to urban referents in the same study (*n*=1,087)		
					Odds ratio	B			Compared to rural referents in the same study (*n*=1,130)		
						B			Compared to urban referents in the same study (*n*=1,087)		
Bjornestad *et al.* (2021) [53]	USA	2018	Farmers (agricultural producers with at least 1000 acres or who owned a dairy farm) ***n*=600**	GAD-7	Prevalence of Generalized Anxiety Disorder (% with GAD-7 ≥5, i.e. 'mild' to 'severe' anxiety)			W	Compared to 12-month prevalence of 'any anxiety disorder' amongst the adult US population; collected between February 2001 and April 2003 using the National Comorbidity Survey Replication data (as per National Institute of Mental Health) i.e. not comparing 'like-for-like'	• Prevalence of anxiety (and depression) is likely to be higher in reality owing to the fact individuals with poor mental health interpreting surveys differently (i.e. experiencing difficulties in understanding questions, skipping questions or neglecting to respond at all). • Social desirability bias in how producers respond to the question was a concern. • Only sampled farmers with 1000 acres+ of land or those who owned a dairy farm; limits comparability.	2 (Medium)
Kallioniemi *et al.* (2009) [45]	Finland	2004	Full-time farmers (male and female) ***n*=1,182**	Survey designed by Raittasalo (1992)	"Have you had, during the previous month, depression or melancholy?" (Yes)		S		Compared to a survey of Finnish working population in 2003 (*n*=3,331) [137] – measure used to assess	• Uses a very basic screening tool for depression, involving only one question.	1 (Low)

[20] ICD-10 causes of death were translated to the ICD-9 codes by Thelin *et al.* using the translator obtained through the National Board of Health and Welfare
[21] ICD-10 causes of death were translated to the ICD-9 codes by Thelin *et al.* using the translator obtained through the National Board of Health and Welfare

									psychological morbidity is unknown because the text is written in Finnish		
Scarth *et al.* (2000) [25]	USA	1994	Iowan male principal farmers ***n*=385**	20-item Centre for Epidemiologic Studies-Depression (CES-D)	% of farmers with a 'high level' of depressive symptoms (CES-D score of ≥16)	B			Compared to National Health Survey (which also used CES-D) for the general US population collected in 1974/75 [86]	• Compares farmer data from 1993/1994 to general population data from a different timeframe (1974/75). • Possibility of underestimation of depression for both states owing to a higher tendency for non-response among depressed farmers.	3 (Medium)
		February – April 1993	Coloradan male principal farmers ***n*=470**			B					
Wheeler *et al.* (2018) [68]	Australia	Secondary data - collected in 2007; 2009; 2011; 2013 [HILDA sample]	Australian farmers ***n*=555**	K10	Prevalence of 'high' and 'very high' levels of psychological distress (% of sample with K10 scores of 22-29 and 30-50)	B			Compared to K10 scores for all Australian non-farmers in the *same* time period (2007-2013) from the same (HILDA) sample (*n*=52,321)	• Comparison of new data with data from a different time frame.	3 (Medium)
			MDB farmers ***n*=223**			B			Compared to K10 scores for Australian non-farmers in MDB in the *same* time period (2007-2013) from the same (HILDA) sample (*n*=7,250)		
		'new data' collected October – November 2015	Horticultural ***n*=315**					W	Compared to K10 scores for all Australian non-farmers in the time period 2007-2013, from the HILDA sample (*n*=52,321)		
			Broad-acre ***n*=270**					W			
			Dairy ***n*=187**			B					
			Livestock ***n*=225**			B					
Lizer and Petrea (2007) [70]	USA	-	'Younger' farmers aged 55-64 **total**	SF-36	(Overall) mental component summary score			W	Compared to other US citizens in a same age	• Small sample size and likely sample bias; sample drawn from Illinois Farm	2 (Medium)
					• Mental health (ME) score			(W)			

			younger and older *n*=87		• Role emotional (RE) score			(W)	groups (unknown source)	Bureau who "may have been more inclined to complete a questionnaire" (p.486).	
					• Vitality (VT) score			(S)			
					• Social functioning (SF) score			(S)			
			'Older' farmers aged 65-74 **total *n*=87**		(Overall) mental component summary score			S			
					• Mental health (ME) score			(W)			
					• Role emotional (RE) score	(B)					
					• Vitality (VT) score	(B)					
					• Social functioning (SF) score	(B)					
Merchant *et al.* (2002) [64]	USA	1994-1998	Farm women ***n*=283**	11-item Centre for Epidemiologic Studies-Depression (CES-D) [valid, standardized]	% with CES-D score ≥8	B			Compared to non-farm, rural women in the same study (n=182)	• Residence type was a poor indicator of whether participants were actively involved in farming at the time of the research: ○ Of the current female farm residents, 42.3 per cent were not/no longer farming. ○ Of the current male farm residents, 5.1 per cent were not/no longer farming. ○ Of the female rural, non-farm residents, 16.1 per cent were currently involved in farming. ○ Of the male rural, non-farm residents, 42.9 per cent were currently involved in farming.	4 (High)
						B			Compared to town women in the same study (n=413)		
			Farm men ***n*=286**			B			Compared to non-farm, rural men (n=140)		
						B			Compared to town men in the same study (n=311)		
			Farm women ***n*=285**	Depression	"Ever treated by a doctor for depression?" % that answered 'Yes'	B			Compared to non-farm, rural women in the same study (n=182)		
								W	Compared to town women in the same study (n=415)		
			Farm men ***n*=290**			B			Compared to non-farm, rural men in the same study (n=141)		
						B			Compared to town men in the same study (n=316)		

										○ Of the female town residents, 4.4 per cent were currently involved in farming. • Of the male town residents, 20.8 per cent were currently involved in farming.	
Kennedy *et al.* (2021) [74]	USA	2003-2016	Farmers ***n*=2801**	Presence of a mental health condition (prior to suicide)	% of farmers with a mental health condition	B			Compared to non-farmers in the same study *n*=137,722	• Sample included anyone living on the farm. • Coronal data is not gathered for the purposes of research, and are therefore varying in both detail and consistency. • Recognises the findings are difficult to generalize beyond the state of Victoria given the regional variability of farming-related suicide highlighted elsewhere in the literature.	3 (Medium)
				Currently in treatment for a mental illness (at the time of suicide)	% of farmers who were receiving treatment for mental illness at the time of their suicide	B					
Kennedy *et al.* (2020) [73]	Australia	2009-2015	Farmers (those residing on farms) ***n*=133**	Diagnosed mental illness (prior to suicide)	% of farmers with a diagnosed mental illness	B			Compared to non-farmers in the same study *n*=1,165	• Sample included anyone living on the farm. • Coronal data is not gathered for the purposes of research, and are therefore varying in both detail and consistency. • Recognises the findings are difficult to generalize beyond the state of Victoria given the regional variability of farming-related suicide highlighted elsewhere in the literature.	3 (Medium)
				Received mental health support more than six weeks prior to death	% of farmers who received mental health support more than six weeks prior to death	B					
Gevaert *et al.* (2018) [51]	Across 28 EU	2015	Farmers with no employer (i.e. self-	WHO-5 Well-being index	Overall mean score			W	Compared to other types of self-employed groups in the same	• Difficulties associated with defining / categorising groups of self-employed.	4 (High)

	member states		employed) aged over 15/16 ***n*=540**						sample (total sample, including farmers *n*=5448)		
Kolstrup *et al.* (2008) [75]	Sweden	Autumn 2002	Swedish dairy and pig farmers ***n*=67**	Copenhagen Psychosocial Questionnaire (COPSOQ)	Average score (where a higher score denoted better mental health)			W	Danish workers aged 20-59 years *n*=1850 using COPSOQ – year of data collection unknown [102]	• Small sample size. • Reliance on self-reported measures. • Comparison to Danish workers rather than Swedish.	2 (Medium)
Cohidon *et al.* (2010) [77]	France	2003	Male farmers (according to 1994 INSEE classification) ***n*=223**	20-item Centre for Epidemiologic Studies-Depression (CES-D) [valid, standardized]	% with CES-D score ≥17 (specific cut off for men)[22]	B			Self-employed, tradespeople, shopkeepers *n*=403 (in the same study)	• Self-reported nature of data collection; "which may produce a circular phenomenon: working conditions may be perceived as more harmful by subjects with depressive symptoms, which may result in overestimating associations" (p. 1140). • Use different levels of cut off for men and women (makes the results hard to compare to other studies who have used a more 'accepted' level of CES-D cut off of ≥16). • Finds identical prevalence of depressive symptoms in males and females – something they claim is unlikely to be accurate in reality.	4 (High)
								W	Managers *n*=1264 (in the same study)		
								W	Associate professionals and technicians *n*=1526 (in the same study)		
						B			Clerks, service and sales work *n*=714 (in the same study)		
								W	Blue-collar workers *n*=1952 (in the same study)		
			Women farmers (according to 1994 INSEE classification) ***n*=116**		% with CES-D score ≥23 (specific cut off for men)			W	Self-employed, tradespeople, shopkeepers *n*=159 (in the same study)		
								W	Managers *n*=776 (in the same study)		
								W	Associate professionals and technicians *n*=1495 (in the same study)		

[22] Although some of these percentage differences are very small – they have been categorised according to their absolute percentages, please refer to the narrative below for exact figures

						B			Clerks, service and sales work *n*=2453 (in the same study)		
						B			Blue-collar workers *n*=522 (in the same study)		
Hanigan *et al.* (2018) [79]	Australia	2015	Farmer not in drought (farmer defined as any persons directly involve in managing a farm; this includes those who manage a farm on behalf of an owner, and both paid and unpaid farm managers) ***n*=1219**	K10	Mean K10 (level of psychological distress) score[23]	B			Non-farmers not in drought from the same study *n*=2458	• Unrepresentative sample; a particularly high proportion of rural women with strong links to the farming community responded to the survey.	4 (High)
			Farmer in drought (farmer defined as any persons directly involve in managing a farm; this includes those who manage a farm on behalf of an owner, and both paid and unpaid farm managers) ***n*=468**			B			Non-farmers in drought from the same study *n*=1135		
Furey et al. (2016) [80]	Ireland	March-July 2015	Active farming men aged 18-80 ***n*=121**	PHQ-8 (removed of question on suicide/self-harm)	Mean PHQ (level of depression) score			W	Comparison to PHQ-8 scores from large US population sample (2006) [103]	• Exclusion of female farmers. • Recruitment of farmers during farm meetings might have biased the sample, i.e. farmers recruited were healthy enough to attend meetings. • Lack of direct comparison to non-farming population (use of US and German population samples).	2 (Medium)
				GAD-7	Mean GAD (anxiety) score			W	Comparison to GAD-7 scores from German population sample (2006) [138]		

[23] The differences in K10 scores have been categorised according to their absolute score differences, please refer to the narrative below for exact figures

Lavender *et al.* (2016) [81]	USA	2006-2009	Farmers (as defined by 2010 Standard Occupational Classification system) who committed suicide	Current depressed mood at the time of suicide	% with depressed mood			W	Comparison to all occupational groups (overall) in the same dataset	• Suicides are often underreported on death certificates, therefore the study may underestimate the number of suicides. • Occupation-specific mortality rates were unadjusted in this study, they may be affected by potential confounding factors e.g. age, sex, race, education and income.	3 (Medium)
				Current mental health problem	% with mental health problem			W			
Earle-Richardson *et al.* (2015) [83]	USA	2009	All farmers (defined as a farmer if their response to "Industry worked in most of life" was agriculture OR was other, declaring an agriculturally-related industry) ***n=536***	Poor mental health days (as per BRFSS Questionnaire)	Prevalence (crude OR)	B			Compared to rural non-farmers in the same study *n*=9,076	• Self-reported nature of the data (although the authors note that two groups – farmers and non-farmers were equally subject to this limitation). • Definition of farmer ('worked in agricultural most of life') is a key limitation; it means the sample could have included unemployed or retired individuals who have previously worked in agriculture.	4 (High)
					Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)			W			
				Depression (as per BRFSS Questionnaire)	Prevalence (crude OR)	B					
					Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B					
				Anxiety disorder (as per BRFSS Questionnaire)	Prevalence (crude OR)	B					
					Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B					
			Male farmers (defined as a farmer if their response to "Industry worked in	Poor mental health days (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)			W	Compared to male rural non-farmers in the same study *n*=4,228		

			most of life" was agriculture OR was other, declaring an agriculturally-related industry)	Depression (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)			W			
				Anxiety disorder (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B					
			Female farmers (defined as a farmer if their response to "Industry worked in most of life" was agriculture OR was other, declaring an agriculturally-related industry)	Poor mental health days (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B			Compared to female rural non-farmers in the same study *n*=4,812		
				Depression (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B					
				Anxiety disorder (as per BRFSS Questionnaire)	Prevalence (adjusted OR – adjusted for age, college/no college, and has regular doctor or health care provider)	B					
Fragar *et al.* (2010) [82]	Australia	-	Farmers and farm managers (as per ANZSCO occupation code) ***n*=181**	K10	Mean K10 (level of psychological distress) score[24]			W	Other managers (in the same study) *n*=139	• Occupations categorised according to ANZSCO sub-major two-digit code; does not account for farmers who may have off-farm work. • Reliance on self-reported measures.	4 (High)
								W	Educational professionals (in the same study) *n*=127		
								W	Health professionals, health and welfare workers (in the same study) *n*=127		
								W	Other professionals (in the same study) *n*=123		
								W	Technicians and trades workers (in the same study) *n*=102		

[24] Although some of these percentage differences are small – they have been categorised according to their absolute percentages, please refer to the narrative below for exact figures

						B			Other community and personal service workers (in the same study) *n*=91		
								W	Clerical, administrative and sales workers (in the same study) *n*=280		
								W	Machinery operators, drivers and labourers (in the same study) *n*=153		
								W	Occupation not specified (in the same study) *n*=213		
						B			Student or carer (in the same study) *n*=143		
						B			Unemployed (in the same study) *n*=52		
						B			Permanently unable to work (in the same study) *n*=151		
								W	Retired (in the same study) *n*=796		
					Prevalence of 'moderate and 'high' levels of psychological distress (% of sample with K10 scores of 16-24 and 25-30)[25]			W	Other managers (in the same study) *n*=139		
						B			Educational professionals (in the same study) *n*=127		
								W	Health professionals, health and welfare workers (in the same study) *n*=127		

[25] Although some of these percentage differences are very small – they have been categorised according to their absolute percentages, please refer to the narrative below for exact figures

								W	Other professionals (in the same study) *n*=123		
								W	Technicians and trades workers (in the same study) *n*=102		
						B			Other community and personal service workers (in the same study) *n*=91		
								W	Clerical, administrative and sales workers (in the same study) *n*=280		
								W	Machinery operators, drivers and labourers (in the same study) *n*=153		
								W	Occupation not specified (in the same study) *n*=213		
						B			Student or carer (in the same study) *n*=143		
						B			Unemployed (in the same study) *n*=52		
						B			Permanently unable to work (in the same study) *n*=151		
								W	Retired (in the same study) *n*=796		

Box 2: Methods/measures used to assess mental health in the studies (definitions & acronyms)

Validated, standardized measures

- Center for Epidemiologic Studies Depression Scale (CES-D)
- Clinical Interview Schedule-Revised (CIS-R)
- Generalized Anxiety Disorder Assessment (GAD-7)
- General Health Questionnaire (GHQ)
- Hospital Anxiety and Depression (HADS-A/D)
- Kessler Psychological Distress Scale (K10)
- Montgomery–Åsberg Depression Rating Scale (MADRS)
- Office of National Statistics (ONS) Subjective Wellbeing score
- Positive and Negative Affect Schedule (PANAS)
- Patient Health Questionnaire (PHQ)
- Structured Clinical Interview for DSM (Diagnostic and Statistical Manual of Mental Disorders) (SCID)
- The Symptom Checklist (SCL-5)
- Short Form Survey (SF-12/36) & Mental Component Score (MCS) domain
- Zung Depression Scale
- World Health Organisation (WHO-5) Wellbeing index
- Copenhagen Psychosocial Questionnaire (COPSOQ)
- Behavioural Risk Factor Surveillance System (BRFSS)

Other measures

- Mental health service use
- Diagnosis of a mental health condition / psychiatric diagnosis
- Treatment of a mental health condition
- Psychiatric disorder listed as cause of death
- Other surveys / self-reported measures