My name is Dr. Methuen Morgan and I am a farmer and an academic at the University of New England Armidale NSW. My research interests are in the area of environmental psychology and in part my PhD explored the impacts of CSG extraction of farmers mental health. As a part of my submission I have included the published peer-reviewed manuscript on the impacts of CSG on farmers mental health. The findings from this research were that CSG is a unique stressor over and above the usual agri-stressors and has a unique contribution to poorer mental health outcomes. The profiling work we did indicates that CSG generates a unique stress profile and somewhat surprisingly farmers who have engaged with the CSG industry are over represented in the CSG Stressed profile.

I am originally from Queensland an in particular Condamine. Indeed my family still live in the Condamine area. My personal experience with the CSG industry has been extensive. The promised economic boom has been followed by local economic devastation. The economic, environmental and social cost to the local area has been enormous. At the beginning the local political and business shout the benefits to all who would listen. They are now hiding their heads in shame. Indeed it has cost local politicians their jobs. The social dislocation and economic destruction has been profound. There has been serious impacts on the underground water supply. And if the underground water is destroyed an agricultural wasteland will be created.

The agricultural sector is a key contributor to the Australian economy. It comprises some 134,000 farming businesses and employs approximately 307,000 people (National Farmers Federation, 2012). The gross value of the products sold by farmers in 2010-11 was $48.7 billion, or three percent of Australia's total gross domestic product (GDP; National Farmers Federation, 2012). However, these figures do not convey the complete agricultural economic story. The inclusion of the value-adding process, together with the agri-businesses involved in providing farm inputs takes the overall value of the agricultural sector to approximately $155 billion, or 12 % of GDP (National Farmers Federation, 2012). In comparison, the mining sector in Australia, which frequently competes with agriculture over land-use, employs some 220,00 individuals (Australian Bureau of Statistics, 2015) and contributes approximately 8.5 % to GDP (Australian Bureau of Statistics, 2014).

Despite the importance of viable and productive agricultural areas to the economy and food security of Australia (Lawrence, Richards, & Lyons, 2013), land use conflicts between agriculture and competing interests, such as the mining sector and urbanization, are not unusual. With an increasing population, the demand for both energy and food – often to be sourced from within the same geographical space – sees these two key drivers of the Australian economy in a classic land-use conflict (Harvey & Pilgrim, 2011). Beneath vast tracts of productive agricultural land lie coal seams containing substantial reserves of natural gas (de Rijke, 2013; Geoscience Australia, 2011). The use of natural gas to generate electricity could reduce greenhouse emissions from coal-fired power stations by as much as 50 % (Victor et al., 2014). However, the extraction of the gas from the coal seams under agricultural land potentially creates a diverse range of environmental, social, and operational challenges. These include concerns surrounding water availability and quality (de Rijke, 2013; Hossain et al., 2013; Navi, Skelly, Taulis, & Nasiri, 2015; Poisel, 2012); negative impacts on agricultural operations (Hand & Smith, 2001); lack of respectful consultation, lack of funding for infrastructure upgrades (O'Kane, 2014); social reconfigurations (de Rijke, 2013); fugitive gas emissions (Maher, Santos, & Tait, 2014); and fragmentation and damage to native vegetation and habitats (Chen & Randall, 2013; Stearns, Tindall, Cronin, Friedel, & Bergquist, 2005; Williams, Stubbs, & Milligan, 2012). Further, there are the consequences of CSG extraction on human health from events such as: possible water and soil contamination, air noise and light pollution, and CSG-related traffic. In a recent review of 109 environmental health studies, Werner, Vink, Watt, and Jagals (2014, p. 1127) concluded that there is a “lack of highly relevant” research into this domain and it “generally lacks methodological rigour”. However, they point out that an “absence of evidence does not mean evidence of absence” and that much more rigorous, longitudinal work is urgently required in this domain (Werner et al., 2014, p. 1138).

There are, of course, those who view the CSG industry in a positive light. Some industries, in particular the manufacturing sector, view CSG as a cost-effective energy source (O'Kane, 2014). Some local governments, such as the Greater Western Downs Shire Council, have embraced the industry in the belief that the employment and business benefits will revitalise flagging rural economies (Courtney, 2010). Further, the Australian Petroleum Production and Exploration Association (2013) and the Queensland Government (2013) argue that CSG extraction in rural and regional Australia will provide a range of both social and economic benefits to areas that have seen limited growth and investment in recent times. In reality, like most other extractive industries CSG developments will bring both costs and benefits to rural and regional Australia (Carrington & Pereira, 2011a, 2011b).

Coal seam gas, also known as coal bed methane, refers to methane trapped within the macropores (i.e., cleats and fractures) and micropores (i.e., capillaries and cavities) of a coal seam (Freij-Ayoub, 2012). These coal seams usually lie between 200 and 1,000 metres below the surface (Australia Pacific LNG, 2015). As a part of the production of CSG, the water pressure within the seam is released and this co-produced water is then treated at the surface (Williams et al., 2012). Approximately 15-20 gigalitres of water were removed from underground aquifers as a consequence of CSG extraction in 2011 (RPS, 2011). It is estimated this may increase to as much as 300 gigalitres each year (Carlisle, 2012). Approximately 540 gigalitres is currently removed from the Great Artesian Basin (which underlies most of the known CSG reserves) in Queensland for agricultural and human uses (RPS, 2011). Of concern to many farmers is the lack of bureaucratic consistency with respect of groundwater extraction. Farmers across the Great Artesian Basin (GAB) have supported and embraced the GAB cap and pipe scheme and extraction limits due to departmental concerns about the sustainability of conventional extraction rates (de Rijke, 2013). However, these concerns about sustainability of the groundwater resources do not appear to apply to the CSG industry (Chen & Randall, 2013; de Rijke, 2013; Randall, 2012). The major CSG basins in Australia are in Queensland (Bowen and Surat), and NSW (Clarence-Moreton, Gloucester, Sydney and Gunnedah) and cover some of Australia’s most productive arable land (see Figure 1; Jones, 2011). There are approximately 7200 active wells in Australia (Australian Petroleum Production and Exploration Association, 2015c), with an estimated 40,000 to be constructed in Queensland alone by 2030 (Carlisle, 2012). Total global estimates of economically recoverable gas from all sources are approximately 719.1 trillion cubic metres (Tcm) (McGlade, Speirs, & Sorrell, 2013). Of this, worldwide CSG reserves are estimated to be 39.2 Tcm, of which Australia has approximately 4.5 Tcm. Societal concern for global warming has provided a potentially moral justification for the expansion in exploration and production of CSG (Cook et al., 2013).

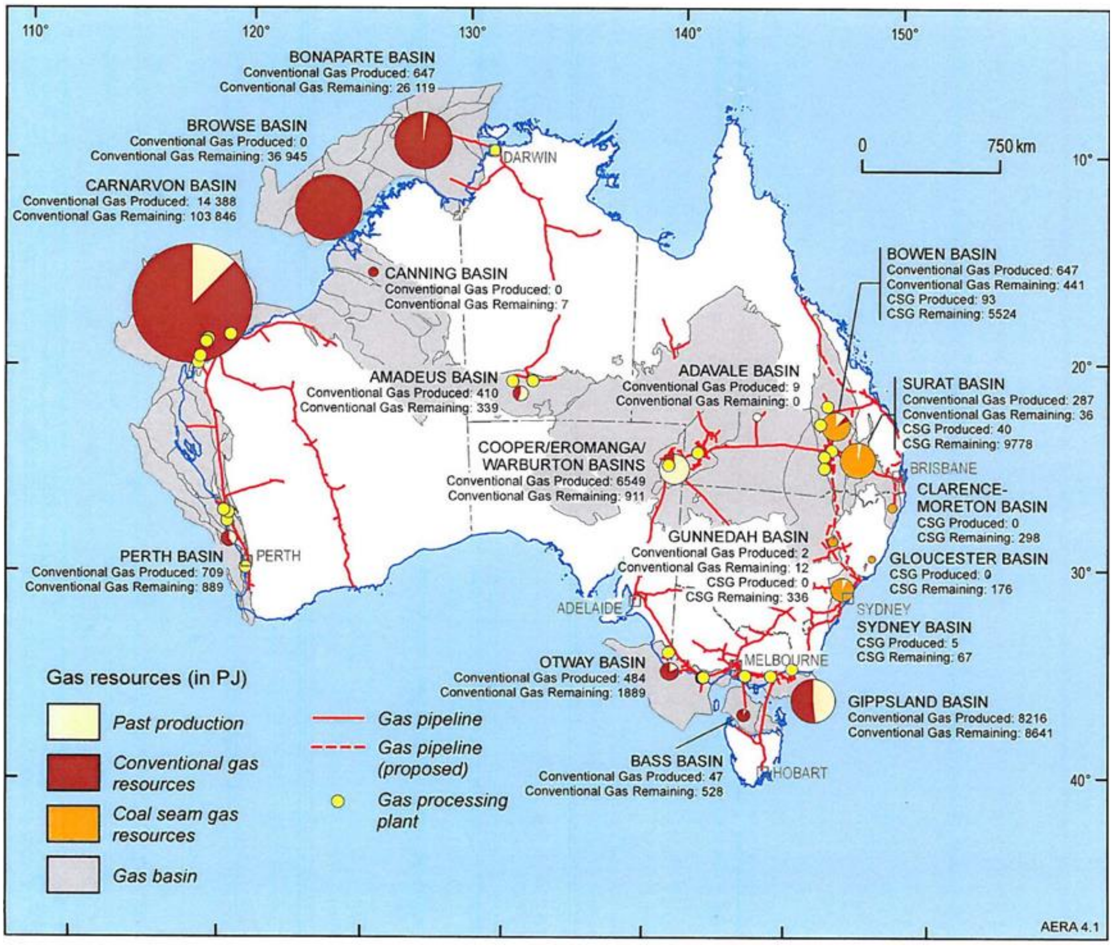

Figure 1.1 Location of Australia's gas resources.

Source: Australian Gas Resources Assessment (BREE, 2012)

Conceptual Overview

Increasing CO_2 emission will require different and effective mitigation options to maintain global temperatures below 2°C relative to pre-industrial levels (IPCC, 2014). Given the significant contribution of coal-fired power stations to the stationary energy sector a plausible argument exists to increase the use of gas-fired power stations as a bridging source until the arrival of required advances in renewable base load power generation (Australian

Petroleum Production and Exploration Association, 2015b; Freij-Ayoub, 2012). With the decline in conventional gas reserves, CSG appears to provide Australia with a viable local alternative source of energy (Freij-Ayoub, 2012). Further, the production and use of CSG is expected to contribute to a reduction in the more than one billion cubic metres of fugitive methane released from coal mines each year in Australia (Freij-Ayoub, 2012). However, the production of natural gas including unconventional sources such as shale and CSG, are not without fugitive gas concerns. Stephenson, Doukas, and Shaw (2012) note that the legitimisation of unconventional natural gas developments has overlooked factors such as fugitive gas emissions including the release of CO_2 from withing the geological formations. Further, the production of CSG proses several notable challenges such as: waste water, air and water contamination, above ground infrastructure, and economic and community changes (Freij-Ayoub, 2012; Walton, Leonard, Williams, & McCrea, 2015; Walton, McCrea, & Leonard, 2014). The net contribution of CSG as a bridging power source is unclear. While it undoubtedly is a cleaner fuel source compared to coal, it is nonetheless a fossil fuel and its extraction creates a range of social, economic and environmental issues.

Farmer Stress and Coal Seam Gas (CSG)

Environmental Stress

Stress is predominately conceptualized as either a stimulus or a response (Lazarus & Folkman, 1984). As a stimulus, stress refers to environmental events (e.g., natural or man-made disasters, retrenchment and severe illness) that would normatively be assessed as stressful (Lazarus & Folkman, 1984). These stress stimuli are more commonly referred to as stressors, which is the term used throughout this thesis. Stress response refers to a physiological outcome within the individual (Lazarus & Folkman, 1984). Although an event/object may be normatively considered stressful, perceptions of stressfulness may vary considerably across individuals (Cohen, Kamarck, & Mermelstein, 1983). Psychological stress is a response to an individual's perception, that the demands of the environment surpass the adaptive capacities to deal with the stressor (Cohen, Janicki-Deverts, & Miller, 2007).

Humans have evolved to survive within a diverse range of ecosystems and built environments, and typically encounter a range of environmental conditions each day (Evans & Cohen, 2004). Environmental conditions refer to the physical properties of the existential domain within which individuals conduct activities (Evans & Kantrowitz, 2002). Many of these conditions support physical and mental health, such as clean air, recreational parks, and clean water. But others – noise, crowding, heat, hazardous wastes and other toxins, for example – do not (Evans & Cohen, 1987; Evans & Kantrowitz, 2002). Although humans have adapted successfully to this diverse range of environments and conditions, it has not been without cost (Evans & Cohen, 2004). These adaptive costs can have various psychological impacts, including negative affect, fatigue, reduced self-efficacy, increased physiological responses, and distorted perceptions of environmental conditions (Evans & Cohen, 2004). Research indicates that the stress associated with living near a hazardous environment such as industrial manufacturing operations, has a direct effect on mental health outcomes (Downey & Van Willigen, 2005).

The growth of CSG operations in regional Australia has resulted in rapid industrial developments in many small rural towns and localities. As a consequence, many of these communities face a range of novel challenges including: increased population growth and the resulting strains on infrastructure and services; reduced housing and accommodation availability and affordability; labour shortages; changes to community values and lifestyles; and increased local traffic (Cook et al., 2013). A substantial body of research into the impacts of mining in rural areas has identified similar challenges (e.g., Carrington & Pereira, 2011a, 2011b; Franks, Brereton, & Moran, 2010; Lockie, Franettovich, Petkova-Timmer, Rolfe, &

Ivanova, 2009; Tonts, 2010). The industrial activity associated with CSG developments on farms and within rural and regional communities potentially adds to the adaptive costs associated with farming.

Farming Stressors

Mental illness is the second largest contributor to the disease burden in Australia, with the social impact of mental illness culminating in a suicide rate amongst rural men up to 2.6 times that of their urban counterparts (National Rural Health Alliance Inc, 2009). Although mental health morbidity within rural and regional Australia is similar to non-rural areas, farmers have a substantially higher suicide completion rate than the national average for employed adults (Andersen, Hawgood, Klieve, Kolves, & De Leo, 2010; Arnautovska, McPhedran, & De Leo, 2014; Australian Bureau of Statistics, 2011; Fraser et al., 2005). A review of research into rural populations in the United Kingdom, Europe, Australia, Canada and the United States of America suggests that “farming is associated with a unique set of characteristics [stressors] that are potentially hazardous to mental health” (Fraser et al., 2005, p. 340). The range of identified stressor domains that contribute to negative mental health outcomes within the farming cohort include: bureaucratic obligation, financial pressures, isolation, climatic variability and events, on-farm hazards, and time pressures (e.g., Booth & Lloyd, 2000; Brannen, Johnson Emberly, & McGrath, 2009; Deary, Willcocks, & McGregor, 1997; Firth, Williams, Herbison, & McGee, 2007; Marshall, Gordon, & Ash, 2010; Sartore, Kelly, Stain, Albrecht, & Higginbotham, 2008). Furthermore, an extensive body of research indicates these unique farming stressors contribute to adverse mental health outcomes in farmers, including increased levels of psychological stress (Booth & Lloyd, 2000), depression and anxiety (Sanne, Mykletun, Moen, Dahl, & Tell, 2004) and suicide (Judd, Cooper, Fraser, & Davis, 2006a; Judd et al., 2006b; Kõlves, Milner, McKay, & De Leo, 2012). Although it is clear that CSG extraction on agricultural land is a “hot-button” issue for many farmers, the contribution of CSG extraction to farmers' global stress burden and the subsequent potential negative impacts on mental health outcomes is not yet clear. I address this issue in Chapter 2.

CSG Extraction and Farmer Stressors

Throughout Australia, and around the world, productive agricultural land is being permanently lost from the food production chain in favour of industries such as mining and urban development, which often provide more attractive short-term financial returns including employment opportunities, local economic activity, and tax revenue (Greer, Talbert, & Lockie, 2011). Extractive resource operations, such as open-cut coal mining, can profoundly affect natural ecosystems, agricultural operations, and social conditions. Further, these extractive operations also have been associated with increased fears of physical illness and elevated distress related to environmental changes among those most directly impacted (Higginbotham, Conner, Albrecht, Freeman, & Agho, 2007; Higginbotham, Freeman, Connor, & Albrecht, 2010). For example, Higginbotham et al. (2007, p. 246) report that some of the consequences of open-cut coal mining in NSW's Hunter Valley are that "families living in mining-affected zones have been relocated to make way for mine developments, while residents left on the fringe of mining and power activities are exposed to degradation of their surroundings through land clearing, pollution by noise, dust, saline water and other emissions, land subsidence, cracks in water courses, house damage from blasting, frequent truck movements, and illumination of night skies by 24-hour open-cut mining operations." The minimal above ground geo-spatial interference of CSG extraction was seen initially as an opportunity for agriculture and mining to co-exist. Indeed, it was viewed by many as a win/win situation for the farmers, local economies and mining (Greer et al., 2011).

However, like the coal mining areas, CSG developments present communities with costs as well as benefits. Proponents of the CSG industry highlight the report the potential for increased employment opportunities, government revenues, regional development, and a reduction of the migration of young people into urban areas (Australian Petroleum Production and Exploration Association, 2015b; Fleming, Measham, & Cai, 2015; Fleming & Measham, 2014; Measham & Fleming, 2014). The extraction of water from the coal seams also offers potential benefits to the local farmers including livestock and domestic water, and aquaculture and industrial uses, depending on the level of tertiary treatment (Letts, 2012). In contrast, those critical of the industry raise concerns about "the impacts on groundwater and aquifers, the extraction or recovery methods used, the treatment and disposal of extracted water, the management of salt and brine, the impact of the whole process on surface water and soils and the implications for agricultural land use where gas production facilities are located on productive land" (Rural Affairs and Transport References Committee, 2011, p. 17). In addition to the multitude of daily and seasonal stressors with which farmers must contend, the arrival of CSG operations within the agricultural landscape provides a potentially significant new range of stressors such as competition for scarce water resources, interference with on-farm operations, environmental degradation, increased traffic, and socially divisive conduct (de Rijke, 2013)

Fracked: Coal Seam Gas Extraction and Farmers' Mental Health

Abstract

Farmers are exposed to a unique range of vocational stressors, and while mental health morbidity is similar to their non-rural counterparts, suicide rates are higher. We examined the contribution of coal seam gas (CSG) extraction to the global stress burden and mental health of 378 Australian farmers (mean age = 53.08 years; *SD* = 10.28). Exploratory factor analysis revealed that CSG items added two unique dimensions to the Edinburgh Farming Stress Inventory: Off-farm CSG Concerns (concerns about possible impacts of CSG extraction on human health, communities, and the environment) and On-farm CSG Concerns (potential CSG impacts on farm profitability, disruption of farm operations, and privacy). Subscales based on the new factors correlated significantly with farmers' self-reported levels of depression, anxiety and stress reactivity, as assessed by the DASS-21. Latent profile analysis categorized farmers into four distinct segments based on their overall stress profiles: *Non-stressed* (39%), *Finance-stressed* (31%), *CSG-stressed* (15%) and *Globally-stressed* (15%). Farmers in the *CSG-stressed* and *Globally-stressed* categories exhibited clinically significant levels of psychological morbidity. This information can be used to inform strategies for improving mental health outcomes in the agri-gasfields of Australia.

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Fracked: Coal Seam Gas Extraction and Farmers' Mental Health

Managing mental health is a serious challenge in many rural communities. Although rural areas experience similar rates of mental health morbidity relative to their non-rural counterparts, the suicide rate of farmers is substantially higher than the national average for employed adults (Andersen et al., 2010; Arnautovska et al., 2014; Australian Bureau of Statistics, 2011). This elevated risk has been attributed to the unique combinations of complex occupational and location-related stressors that confront farmers including: debt burden, isolation, farm hazards, time pressure and dependency on weather and other environmental factors (Deary et al., 1997; Firth et al., 2007). In addition to these widely recognized stressors, new concerns related to coal seam gas (CSG) extraction in traditional food-producing areas may further increase the stress burden on farmers.

Beneath vast tracts of productive farmland in Australia lie enormous quantities of CSG. Licensed explorers are awarded extraction leases to develop these potentially productive CSG reserves (Chen & Randall, 2013). Since 1995, the CSG industry has expanded rapidly, resulting in escalating tensions between farmers and CSG operators (Chen & Randall, 2013). Of particular concern to farmers are perceived threats related to aquifer integrity, sustainability, pollution, property access, on-farm privacy, public road traffic and social dislocation (de Rijke, 2013). In this study, we investigate the extent to which farmers' concerns and experiences with CSG extraction contribute to their overall stress burden and consequent potential impacts on their mental health.

1.1 Coal Seam Gas

Coal seam gas, also known as coal bed methane, is found within the natural fractures and micro-pores of coal (Williams et al., 2012). Extracting CSG requires reducing the water pressure within the coal seam to allow the gas to escape and, where appropriate, high pressured hydraulic fracturing ('fracking') of the coal seam (Williams et al., 2012). There are approximately 7500 wells currently operating in Australia, with future estimates of up to 40,000 projected by 2020 (Australian Petroleum Production and Exploration Association, 2015a; Carlisle, 2012). Approximately 15-20 gigalitres were removed from underground aquifers as a consequence of CSG extraction in 2011 (RPS, 2011). It is estimated this may increase to as much as 300 gigalitres each year (Carlisle, 2012). In contrast, approximately 540 gigalitres is currently removed from the Great Artesian Basin (which underlies most of the known CSG reserves) in Queensland for agricultural and human uses (RPS, 2011). The exact social, economic, and environmental consequences of CSG extraction remain uncertain (de Rijke, 2013).

CSG operations offer clear short- and medium-term economic benefits, but concerns have been raised about potential negative impacts on agricultural productivity and individual well-being (Stearns et al., 2005; Stepans, 2008). Recent research suggests that the arrival of resource extractive industries such as CSG heralds a rapid expansion of local economic activity, and a reduction in both rural poverty and youth migration from rural to urban areas (Measham & Fleming, 2014; Schafft, Borlu, & Glenna, 2013). In contrast, other research identifies the potential harm to agricultural operations. These include: the depletion of underground aquifers, increased water salinity (Geiger, 2007), destroyed agricultural land (Hand & Smith, 2001), and environmental concerns such as fugitive gas emissions, the emergence of invasive species, reduced flora and fauna tolerance levels and erosion (Bergquist, Evangelista, Stohlgren, & Alley, 2007; Maher et al., 2014). These potentially harmful impacts, the primary burden for which will be borne by agricultural communities, may constitute an additional significant stressor facing farmers – many of whom already carry a substantial stress burden associated with agriculture.

Government support of CSG extraction implicitly (and in some instances explicitly) endorses some version of a co-existence model between farmers and CSG operators. Farmer support around the world for CSG extraction on agricultural land is highly variable. This may be the consequence of the different landowner mineral rights that exist in the different common law jurisdictions (Hunter, 2012). For example, US landowners retain absolute power over their land including the resources below the ground, whereas in Australia the Crown (or Australian Government) retains ownership of all fossil fuels and minerals and can grant a title to a third party for exploration and extraction (Hunter, 2012). Research suggests that US landowners engaged with CSG developments are more likely to hold positive opinions of the industry mainly due to receiving compensation and/or employment opportunities within the industry than those farmers who have "no lease or development" on their property (Jacquet, 2012). Reported compensation for the siting of CSG wells on farm land in Australia varies with reports ranging from hundreds of dollars per well per year to many thousands. It remains unclear as to how this engagement with the CSG industry influences the stress burden of farmers.

1.2 Farmer Stress

Psychological stress occurs when the demands in an individual's environment surpass their perceived capacity to cope (Cohen et al., 2007). Occupational stress is psychological stress created from within a workplace and has been linked to a host of psychosocial outcomes including: reduced job satisfaction, well-being, and self-rated heath; burnout and depression (Edwards & Burnard, 2003; Kopp, Stauder, Purebl, Janszky, & Skrabski, 2007). Although not all stress is detrimental, severe or prolonged stress can have serious impacts on the physical and mental health of farmers (Berry, Hogan, Owen, Rickwood, & Fragar, 2011; Raine, 1999). Many of the stressors confronting the Australian farming community, such as weather, economic viability, and operational debt often fall within the severe and/or prolonged category.

Numerous studies have examined the relationship between individual agricultural stressors and the mental health outcomes of farmers. For example, drought events have consistently been identified as a contributor to adverse mental health states such as depression and anxiety (Alston & Kent, 2008; Gunn, Kettler, Skaczkowski, & Turnbull, 2012; Hart, Berry, & Tonna, 2011; Polain, Berry, & Hoskin, 2011; Sartore et al., 2008; Stain et al., 2011; Staniford, Dollard, & Guerin, 2009). Likewise, flood events and bio-hazard threats, like foot-and-mouth disease, have been associated with higher levels of psychological morbidity within farming communities (Hoyt, Conger, Gaffney Valde, & Weihs, 1997; Peck, Grant, McArthur, & Godden, 2002). Research into rural populations in the United Kingdom, Europe, Australia, Canada and the US suggests “farming is associated with a unique set of characteristics [stressors] that are potentially hazardous to mental health” (Fraser et al., 2005, p. 340).

There is an extensive body of research linking environmental stressors, such as noise, pollution, heat, and crowding, to negative mental health outcomes (for reviews see; Evans & Cohen, 1987; Evans & Cohen, 2004). Other studies have examined farmer stress from a broader, multidimensional perspective. Deary et al. (1997) developed the Edinburgh Farming Stress Inventory (EFSI), which identified six distinct stress domains associated with agriculture: farming bureaucracy, finance, isolation, acts of God, personal hazards, and time pressure. Subsequent studies by other research groups have identified similar domains (e.g., Brannen et al., 2009; Firth et al., 2007; Pollock, Deaville, Gilman, & Willock, 2002; Simkin, Hawton, Fagg, & Malmberg, 1998). Several of these stress factors have been linked to psychological morbidity. For example, financial concerns, bureaucracy, and experiencing on-farm hazards such as foot-and-mouth disease, have all been associated with elevated levels of stress that contribute to depression (Peck et al., 2002), suicidal ideation (Turvey, Stromquist, Kelly, Zwerling, & Merchant, 2002) and suicide (Malmberg, Simkin, & Hawton, 1999). While there is empirical research examining the psychological impacts of extractive industries such as coal mining (e.g., Connor, Albrecht, Higginbotham, Freeman, & Smith, 2004; Higginbotham et al., 2007), we were unable to identify any studies that assessed the association between CSG stressors and farmer mental health outcomes.

1.3 Current Study

The rapid expansion of CSG operations into traditional food-growing areas provides a new, potentially significant source of stress for Australian farmers. To date, there has been little empirical research investigating how concerns about CSG contribute to farmers' overall stress burden and its potential effects on mental health. The current study extends past research in four important ways.

First, we expanded Deary et al.'s (1997) EFSI to include 11 new items related to on- and off-farm stressors linked to CSG extraction. We predicted that these items would add at least one new CSG-specific factor to Deary et al.'s (1997) 6-factor farmer stress model (farming bureaucracy, finance, isolation, acts of God, personal hazards, and time pressure).

Second, this is the first study to investigate whether CSG-specific stressors explain unique variance in farmers' mental health after controlling for other traditional farm stressors assessed by the EFSI. We hypothesized that, after controlling for the EFSI stress factors, CSG concerns would explain unique variance in depression, anxiety and stress reactivity – the most common mental health disorders in the Australian population (Australian Bureau of Statistics, 2007).

Third, we extended the literature on farmer stress by developing a typology of farmers based on their perceptions of agricultural stressors they encounter. In particular, we were interested in determining the number of distinct stress profiles present in our sample of farmers – whether or not unique profiles related to CSG concerns would emerge, and whether profile membership could predict farmers' mental health status.

Finally, we explored whether the farmer stress profile membership was associated with current levels of farmer engagement with the CSG industry. It is reported that farmers engaged with the CSG industry are more likely to hold positive views due to financial benefits such as compensation and/or employment opportunities compared to those farmers without leases on their property (Jacquet, 2012). While farmers in Australia are compensated, recent media and social media reports suggest many farmers hold an unfavourable view of the CSG industry and opposition is increasing (e.g., Mitchell, 2014; Northdurft, 2014; Williams, 2014). The current study was designed to help shed additional light on this important issue.

2. Method

2.1 Participants

Participants were 378 Australian farmers, 191 males (M = 54.05 years, SD = 10.63), 185 females (M = 51.96 years, SD = 9.78) and two participants who did not disclose their gender. According to Australian Bureau of Statistics (2012), 72% of Australian farmers are male and 28% female with a mean age of 53 years. Australian farmers are defined by the Australian Bureau of Statistics (2012, p. 3) as "those people who were employed during the week prior to the Census of Population and Housing and who reported that their main occupation was a farmer or farm manager". In contrast, the current study included farmers and their partner who may have other occupations but are part of the ownership/management of the property; this could be the reason why our sample comprised more females than the census data. The majority of respondents were from Queensland (n = 181, 47.8%) and New South Wales (n = 154, 40.7%). There were 20 respondents from Victoria (5.1%), and 3 (> 1%) from the other states. Twenty participants did not disclose their postcode. In terms of engagement with the CSG industry, 155 (41%) farmers indicated that a CSG company had an extraction lease on their property but they had yet to be approached by the CSG operator, 34 (9%) had been approached by CSG operators but had rejected the offers made to them, 64 (17%) indicated they had recently negotiated an outcome or would soon commence negotiations, 125 (33%) believed that there was no lease on their property.

In terms of education, 1.3% of participants reported that they had attained primary school level education while a further 24.1% reported to have completed some level of secondary schooling. Just over one-third (37.5%) of the farmers reported having completed a tertiary-level education (i.e., bachelor degree or higher). Other non-school qualifications (e.g., TAFE, and agricultural college) were achieved by 37.1% of the sample. This compares with 24% of the general population holding a bachelor degree or better and 42% achieving some other non-school qualification respectively (Australian Bureau of Statistics, 2010).

2.2 Procedure

Prior to data collection, we approached three agri-political organization's (New South Wales Farmers' Association, AgForce and Lock the Gate) to assist with recruitment. All three groups provided a link to the study for members on their respective web pages and member email alerts. Data collection was primarily conducted online using Qualtrics online survey software. To address potential online hijacking of the survey, Qualtrics' "ballot stuffing" prevention option was engaged. This security option monitors IP addresses to prevent participants from engaging in the survey more than once. In addition, 76 respondents completed hardcopies of the survey distributed at CSG information forums and information days in Queensland and New South Wales, Australia.

2.3 Measures

The survey consisted of 374 questions assessing outcome expectancies, property protective behaviours, agricultural stressors, mental health, subjective well-being, self-efficacy, coping, place attachment, trust and demographic constructs. The current study restricted itself to agricultural stressors, engagement status, depression, anxiety and stress reactivity, which are described below. The Cronbach's alphas (α) reported below reflect internal consistencies for each measure obtained in the current sample.

Farmer Stressors. Farmers' responses to farm-related stressors were assessed using a 44 item adapted version of the Edinburgh Farming Stress Inventory (EFSI, Deary et al., 1997). Following the approach used by Firth et al. (2007), we modified several of the original EFSI items and added new items associated with the stress domain of interest in this study. We retained 20 items of the 27 original items from the EFSI measure (Deary et al., 1997), four items generated by Firth et al., (2007), and added 20 new items (nine agricultural and 11 CSG) developed specifically for this study[1]. These new items were generated from the responses from two separate pilot studies. The first study consisted of 40 farmers who were asked to list the perceived benefits and costs associated with the CSG industry as it related to their property and communities. The second involved 20 farmers who provided feedback on the modified farmer stress scale after the new CSG items had been added. These respondents were asked to identify any usability issues and any gaps in the scale. In response to this feedback, several minor wording changes were made and nine new items were added to the scale. The adapted version assesses farmer stress dimensions: Farming Bureaucracy, Finance, Isolation, Acts of God, Personal Hazards, Time Pressures, and Coal Seam Gas Extraction. Nine items were modified to better reflect Australian farming conditions and terminology. For example, “Significant production loss due to disease/pest/weeds” (Deary et al., 1997) was replaced with “Reduced yields due to adverse weather (e.g., rain or lack of it at the wrong time, early/late frost, etc.)”. An item “Handing on farm fairly” (Firth et al., 2007) was modified to a more common Australian term “Succession planning”. Participants were instructed to “*Indicate the severity of the stress caused by each of the following events during the previous 12 months”*. Items are rated on a 5-point Likert scale ranging from 1 (*None*) to 5 (*Very Severe*). The results of an exploratory factor analysis applied to this measure, including a list of all items and Cronbach’s αs for each subscale, are reported in Table 1.

Depression, anxiety and stress reactivity. Farmers’ mental health outcomes were assessed using the Depression Anxiety Stress Scales (DASS-21, Lovibond & Lovibond, 1995), a 21-item self-report measure of the severity of core symptoms of depression (e.g., dysphoria, anhedonia, hopelessness), anxiety (e.g., autonomic arousal, panic) and stress

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[1] Two items did not load on to either CSG factor. They were: ‘The negative impact of CSG extraction on the water supply’ and ‘Decline in agricultural yield as a result of CSG activity’.

reactivity (e.g., tension and behavioural responses to stress)[2]. Each subscale comprises seven items. Based on their experience over the previous four weeks, participants rated the items on a 4-point scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). Items in each subscale are summed to provide scores for symptoms of depression, anxiety, and stress reactivity, with higher scores indicating greater severity of symptomatology. In the present study, total scores for each subscale were doubled to enable comparisons with DASS-42 norms (Lovibond & Lovibond, 1995): (1) Depression: (0-9 *normal;* 10-13 *mild*, 14-20 *moderate*, 21-27 *severe*, 28+ e*xtremely severe*), (2) Anxiety: (0-7 *normal*, 8-9 *mild*, 10-14 *moderate*, 15-19 *severe,* 20+ *extremely severe*)*, and* (3) Stress reactivity (0-14, *normal*, 15-18 *mild*, 19-25 *moderate*, 26-33 *severe* and 34+ *extremely severe*). Cronbach's αs for depression, anxiety and stress reactivity were .89, .85, and .89, respectively.

Engagement with CSG industry. Farmer engagement status with the CSG industry was assessed with a single item comprising six options. Participants were asked "*Which of the following best describes the status of Coal Seam Gas (CSG) development on your property?"* Options included: (1) *No CSG exists on my property that I am aware of*; (2) *CSG leases exist on my property, but no approach has yet been made by a CSG company;* (3) *CSG leases exist on my property and the approaches made by the CSG company have been rejected*; (4) *CSG leases exist on my property, an approach has been made to me by the CSG company and negotiations will/have commenced*; (5) *CSG leases exist on my property and exploration has/will commence*; and (6) *CSG leases exist on my property and production has commenced*. Options 4, 5, and 6 were combined into a single 'engaged' category resulting in four levels of engagement: (1). *No lease*, (2). *Lease – No approach*, (3). *Lease – Rejected*, (4). *Engaged*. Given this measure is categorical, no Cronbach's α was computed.

[2] The adapted EFSI used in this study assesses cognitive evaluations of stress severity across multiple domains of relevance to famers. This contrasts with DASS-21: stress reactivity subscale which assesses general feelings of tension and behavioural reactivity without reference to specific causes.

3. Results

3.1 Data Screening

Of the 432 farmers who completed the survey, 46 (13%) cases were deleted because of excessive missing data (>50%) and a further eight (2%) were excluded for failing to complete the item addressing engagement status with the CSG industry. Missing values across the measured items ranged from 0 to 1.9%. Missing data were imputed using the expectation maximization algorithm in IBM SPSS 20 (IBM Corp, 2011).

3.2 Farm Stressor Dimensions

An exploratory factor analysis, using Maximum Likelihood, was conducted on the adapted EFSI to determine its latent structure. The scree plot indicated three factors should be retained, whereas Kaiser's rule (eigenvalues greater than 1) suggested nine. We applied a Promax rotation (Kappa = 4) to all solutions between 3 and 9, and found the 9-factor solution to be the most interpretable. This solution explained 67% of the overall variance in the dataset. Following the criteria used by Deary et al. (1997), items with pattern-matrix loadings of .50 or above and cross-loading lower than .30 were used to name each factor[3]. At least three items were retained for each factor. Subscale scores for each factor were calculated using the mean score of the relevant items, with higher scores indicating more perceived stress[4]. A summary of items, factor loadings, and Cronbach's αs for the resulting subscales is presented in Table 2.1[5].

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[3]The loading criteria on two factors were relaxed to below .50 to enable a third item to be included in the Economic Viability and Operational Debt subscales.

[4] For the sake of brevity, accuracy, and relevance to the Australian context, several of the original EFSI factors were re-named. Farming bureaucracy became Bureaucracy, Time Pressures became Time, Acts of God became Environmental Demands, and Personal Hazards were renamed as Farm Hazards. Isolation in the original measure is renamed Social Isolation to more accurately reflect the content of the scale.

[5] Of the 10 items that did not load onto a factor, eight items fail to reach the criteria of .5 and two items provided cross-loadings over .3.

Table 2.1

Exploratory Factor Analysis: Factor scales, Items, and Loadings for the Adapted EFSI

Factor scale and Item	Loading	α
Factor 1: Time Pressures (5 items)		.85
Long hours of work	.97	
Too much work and too little time	.91	
Increased work load at peak times	.65	
Unplanned interruptions to daily farm activity	.59	
Few holidays away from farm	.53	
Factor 2: Bureaucracy (5 items)		.86
New environmental regulation	.89	
Dealing with government bodies (e.g., workers compensation, environment and resource departments, etc.)	.76	
Adjusting to new bureaucratic regulations and policy (e.g., carbon tax, etc.)	.76	
Complying with bureaucratic requirements (e.g., GST compliance, NLIS, etc.)	.73	
Complying with occupational health and safety requirements	.57	
Factor 3: Weather (3 items)		.83
Extreme weather events (e.g., drought, floods, bushfire, etc.)	.92	
Reduced yields due to adverse weather conditions (e.g., rain or lack of at the wrong time, early/late frost, etc.)	.78	
Unpredictability of the weather	.75	
Factor 4: Social Isolation (3 items)		.79
Having no-one to talk to all day	.88	
Lack of close neighbours	.83	
Feeling alone and isolated	.80	
Factor 5: Farm Hazards (3 items)		.79
Presence of hazardous on-farm materials (chemicals, etc.)	.79	
Bio-hazard threats from imported produce	.78	
Farming related accidents	.61	
Factor 6: Economic Viability (3 items)		.82
Declining commodity prices	.69	
Rise in input prices	.64	
Concerns about the continuing viability of the farm	.41	
Factor 7: Operational Debt (3 items)		.79
Current level of debt	.85	
Not enough ready cash	.63	
Rising interest rates	.38	
Factor 8: Off-farm CSG Concerns (5 items)		.86
Worry about my children's future as a result of CSG activity	.79	
Reduction in property valuations due to CSG developments	.68	
The degradation of the environment due to CSG activity	.75	
The threat to human health as a result of CSG activities	.64	
Deteriorating community values as a result of the influx of CSG workers	.58	
Factor 9: On-farm CSG Concerns (4 items)		.91
The negative impact of CSG activities on the daily operation of my property	.87	
The loss of privacy due to CSG personnel on my property	.86	
Impact of CSG operations on the profitability of my property	.76	
Inter-personal dealings with CSG company representatives	.71	

Note. Out of 44 items, eight items did not load at .5 and two items produced cross loadings over .3. Details of these items can be provided by the first author.

The first factor, labelled *Time Pressures* consisted of five items relating to the considerable time investment required for day-to-day farming operations. *Bureaucracy*, the second factor, comprised five items addressing various compliance requirements of governmental agencies. The third factor, *Weather,* included three items assessing concerns about the impact of adverse weather on farming. *Social Isolation*, the fourth factor, comprised three items focusing on working alone and spatial separation. The fifth factor, *Farm Hazards*, included three items relating to on-farm risks such as imported bio-hazards and hazardous on-farm chemicals. *Economic Viability*, the sixth factor, comprised three items relating to external economic factors, such as commodity prices and input costs, affecting the viability of farming. The seventh factor, *Operational Debt*, included three items related to concerns about personal financial liability and cash flow. *Off-farm CSG Concerns*, the eighth factor, consisted of five items relating to concerns about possible impacts of CSG extraction on human health, communities, and the environment. Finally, *On-farm CSG Concerns* comprised four items related to potential CSG impacts on farm profitability, disruption of farm operations, and privacy.

3.3 Descriptive Statistics

Means, standard deviations and inter-correlations for all major study variables are presented in Table 2.2. Most of the Farmer Stress subscales were positively inter-correlated, with all but one of these correlations (between On-farm CSG Concerns and Weather) reaching statistical significance. In terms of mental health, the majority of respondents had depression and anxiety scores that fell within the normal range (based on DASS-42 norms). The percentage of the sample experiencing clinically significant levels (i.e., above the normal range) of depression (scores > 9) anxiety (scores > 7), and stress reactivity (scores > 14) were 34.9%, 18.8%, and 25.9%, respectively.

Table 2.2

Summary of Inter-correlations among the Farming Stressor Subscales and the Repeated Measures ANOVA

	1	2	3	4	5	6	7	8	9
1. Time Pressures	_								
2. Bureaucracy	.50***	_							
3. Weather	.46***	.33***	_						
4. Social Isolation	.47***	.38***	.18***	_					
5. Farm Hazards	.37***	.51***	.23***	.39***	_				
6. Economic Viability	.53***	.57***	.50***	.29***	.44***	_			
7. Operational Debt	.53***	.43***	.55***	.38***	.33***	.55***	_		
8. Off-farm CSG Concerns	.25***	.35***	.17**	.25***	.50***	.33***	.25***	_	
9. On-farm CSG Concerns	.19***	.41***	.09	.24***	.38***	.27***	.18***	.64***	_
M	2.60[b]	2.53[b]	2.87[a]	1.62[d]	2.01[c]	3.06[a]	2.46[b]	3.07[a]	2.17[c]
SD	.91	.92	1.03	.76	.98	1.04	.98	1.18	1.30

Note: $N = 378$, $^{***}p < .001$, $^{**}p < .01$. Means with different superscripts differ significantly at $p < .05$

3.4 Farmer Engagement Status and Stressor Response

To determine which of the nine stress dimensions elicited the highest levels of perceived stress among sampled farmers, we conducted a one-way repeated measure analysis of variance (ANOVA). The analysis produced a significant effect for stressor type, $F(5.35, 1988.05) = 135.17$, $p < .001$, $\eta^2 = .26$, indicating that some stressor types elicited more stress than others.[6] Means for each stressor type and Bonferroni-adjusted pairwise comparisons are presented at the bottom of Table 2. These analyses revealed four distinct groupings. Perceived stresses linked to Off-farm CSG Concerns, Weather, and Economic Viability subscales were rated significantly more severe than stresses associated with Time Pressures, Bureaucracy, and Operational Debt, which in turn were rated as significantly more severe than Farm Hazards and On-farm CSG Concerns. Stress related to Social Isolation was rated significantly less severe than all other stress dimensions examined in the present study.

3.5 Farming Stressors Predicting Mental Health

We conducted three standard multiple regression analyses to determine whether stress associated with CSG extraction (i.e., Off-farm and On-farm CSG Concerns) predicted unique variance in farmers' depression, anxiety, and stress reactivity after controlling for the other stress domains (i.e., Time Pressures, Bureaucracy, Weather, Social Isolation, Farm Hazards, Economic Viability, and Operational Debt). These results are summarized in Tables 2.3, 2.4 and 2.5.

[6] Mauchly's test of Sphericity was violated. Greehouse-Geisser results are reported.

Table 2.3

Summary of Simultaneous Regression Analyses: Farming Stressor Subscales as Predictors of Depression, Anxiety and Stress Reactivity

Predictors	*R*	*Adj.R*^{2}	*B*	95% CI for *B*		*β*	*r*	*sr²*
				LB	UB			
Depression	.46***	.19						
Time Pressures			.61	-.57	1.76	.07	.22***	<.01
Bureaucracy			.47	-.67	1.62	.05	.19***	<.01
Weather			-.32	-1.26	.62	-.04	.04	<.01
Social Isolation			4.46***	3.25	5.66	.41	.42***	.13
Farm Hazards			-1.21	-1.11	-1.99	-.14	.12*	<.01
Economic Viability			-.55	-1.18	.49	-.07	.09	<.01
Operational Debt			-.13	-2.22	.93	-.01	.14**	<.01
Off-farm CSG Concerns			.97*	.07	1.87	.14	.21***	.01
On-farm CSG Concerns			.41	-.37	1.21	.06	.21***	<.01
Anxiety	.50***	.23						
Time Pressures			1.58**	.78	2.38	.24	.33***	.04
Bureaucracy			.29	-.52	1.09	.04	.21***	<.01
Weather			-.18	-.84	.47	-.03	.04	<.01
Social Isolation			2.75***	1.90	3.59	.35	.44***	.10
Farm Hazards			.04	-.67	.75	<.01	.21***	<.01
Economic Viability			-1.22**	-1.95	-.50	-.21	.07	.03
Operational Debt			.04	-.71	.78	<.01	.21***	<.01
Off-farm CSG Concerns			.55	-.07	1.18	.11	.20***	<.01
On-farm CSG Concerns			-.02	-.57	.53	<-.01	.16**	<.01
Stress Reactivity	.54***	.28						
Time Pressures			3.33***	2.22	4.44	.35	.45***	.07
Bureaucracy			.62	-.50	1.74	.07	.28***	<.01
Weather			.26	-.65	1.16	.03	.20***	<.01
Social Isolation			2.79***	1.62	3.95	.25	.39***	.04
Farm Hazards			-1.04	-2.02	-.06	-.12	.20***	<.01
Economic Viability			-1.11	-2.12	-.11	-.13	.19**	<.01
Operational Debt			.18	-1.20	.84	-.02	.25***	<.01
Off-farm CSG Concerns			1.56**	.69	2.43	.22	.30***	.02
On-farm CSG Concerns			.10	-.66	.87	.02	.23***	<.01

Note. B = unstandardized beta coefficients, *β* = standardized beta coefficients, *r* = zero-order correlation, and sr^2 = squared semi-partial correlation (amount of unique variance in the DV explained by a predictor after controlling for the other predictors in the model). $^{*}p < .05$, $^{**}p < .01$ $^{***}p < .001$.

Table 2.4

Model Fit Indices for Two to Six Profile Solutions

Profile solution	BIC	Entropy	LMR (*p*-value)
2	9064.58	.86	.000
3	8924.96	.80	.152
4	8791.84	.86	.035
5	8729.07	.85	.027
6	8701.62	.86	.188

Note. BIC = Bayesian information criterion, LMR = Lo-Mendell-Rubin likelihood ratio test. A significant LMR test indicates that a given profile solution fits the data significantly better than the solution with one fewer profile group

Table 2.5

Summary of the Farming Stressor Subscales, Depression, Anxiety and Stress Reactivity Scores for the Four Farmer Stress Profiles

	Profile 1: Non-stressed		Profile 2: Finance-stressed		Profile 3: CSG-stressed		Profile 4: Globally-stressed		Univariate	
Profile Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	η^2
Time Pressures	2.03^{a}	0.63	3.08^{c}	0.82	2.35^{b}	0.77	3.38^{d}	0.72	69.96***	0.36
Bureaucracy	1.93^{a}	0.68	2.76^{b}	0.74	2.52^{b}	0.76	3.67^{c}	0.65	86.56***	0.41
Weather	2.37^{a}	0.77	3.53^{b}	0.91	2.27^{a}	0.79	3.43^{b}	0.99	57.36***	0.32
Social Isolation	1.34^{a}	0.49	1.74^{b}	0.80	1.39^{a}	0.42	2.38^{c}	0.95	35.58***	0.22
Farm Hazards	1.47^{a}	0.59	2.19^{b}	0.87	1.71^{a}	0.70	3.37^{c}	0.84	92.58***	0.43
Economic Viability	2.23^{a}	0.77	3.76^{c}	0.74	2.90^{b}	0.63	3.93^{c}	0.73	123.70***	0.50
Operational Debt	1.87^{a}	0.68	3.01^{b}	0.90	2.02^{a}	0.59	3.36^{c}	0.84	79.86***	0.39
Off-farm CSG Concerns	2.26^{a}	0.98	3.15^{b}	0.97	3.73^{c}	0.81	4.38^{d}	0.58	461.13***	0.79
On-farm CSG Concerns	1.29^{a}	0.43	1.60^{b}	0.60	3.69^{c}	0.78	4.13^{d}	0.75	88.19***	0.41
Depression	6.23^{a}	7.07	7.73^{ab}	7.11	9.58^{bc}	10.38	11.34^{c}	9.97	6.21***	0.05
Anxiety	2.93^{a}	5.17	3.69^{a}	5.07	3.86^{a}	5.64	7.56^{b}	8.34	8.75***	0.07
Stress reactivity	7.86^{a}	7.07	12.27^{b}	8.33	11.48^{b}	7.33	16.83^{c}	10.91	17.79***	0.13

Notes. N = 378. The multivariate results for the nine Farmer Stressor subscales: Wilks' λ = .06, F (30, 1072.02) =58.65, p < .001, Partial η^2 = .62. For the three mental health variables: Wilks λ = .84, F (9, 905.50) = 6.98, p < .001, Partial η^2 = .05. All Univariate F's are significant at p < .001. Means with different superscripts (in rows) differ significantly at p < .05. The normality assumption for depression and anxiety was violated. A logarithmic transformation was conducted. Given that the untransformed and transformed data produced the same substantive results, we only reported the analyses based on the untransformed data in the present study.

As a set, all nine farmer stress subscales explained 19% of the variance in depression, 23% in anxiety, and 27% in stress reactivity. Off-farm CSG Concerns (about health, environmental and community impacts) explained significant unique variance in depression (1%) and stress reactivity (2%) after controlling for the other stress dimensions. Off-farm and On-farm CSG Concerns were both significantly correlated with anxiety, but did not explain significant unique variance in this mental health outcome after controlling for the other stress dimensions.

3.6 Farmer Stress Typology

A latent profile analysis (LPA) was conducted using MPlus 6.0 (Muthén & Muthén, 2010) to develop a typology of farmers based on their pattern of responses on the nine Farmer Stress subscales. Relative model fit was assessed using the Bayesian information criteria (BIC; Schwarz, 1978), relative entropy (Ramaswamy, Desarbo, Reistein, & Robinson, 1993), the Lo-Mendell-Rubin likelihood ratio test (LMR; Lo, Mendell, & Rubin, 2001). The resulting fit indices for the 2 through 6 profile solutions are presented in Table 2.4. The LMR test indicated that the 4-profile solution fit the data significantly better than the 3-profile, that the 5-profile solution fit better than the 4-profile, and the 6-profile solution did not fit better than the 5-profile. Given that the BIC and entropy values for the 4- and 5-profile solutions were very similar, we investigated these two solutions in more depth. The main difference was that the 4-profile solution included a single unstressed group, which scored well-below the mid-point on all nine farmer stress dimensions, whereas the 5-profile solution included two such groups. Given this split reflected a relatively small quantitative shift, as opposed to qualitatively different groups, we chose to interpret the 4-profile solution. We labelled the segments *Non-stressed*, *Finance-stressed*, *CSG-stressed*, and *Globally-stressed*. A visual depiction of the segmentation solution is presented in Figure 2.1. Means for all segmentation variables and the mental health variables for each segment are presented in Table 2.5.

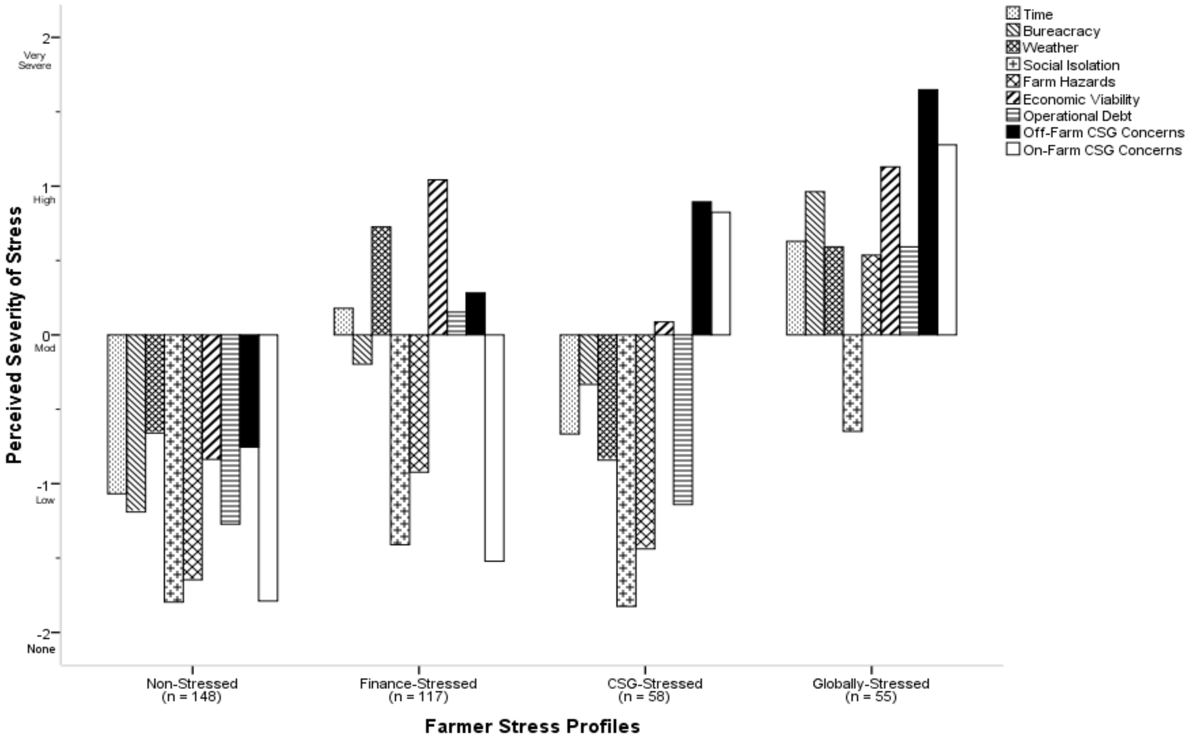

Figure 2.1. Farmer Stressor Scale profile segments

Non-stressed farmers constituted the largest segment in the study (*n* = 148, 39.2%). These farmers scored well below the midpoint on all nine of the farmer stressors, indicating that none of these domains elicited high levels of stress. The absence of perceived stress was also reflected in their average depression, anxiety and stress reactivity scores, all of which fell within the normal range in terms of clinical significance.

Finance-stressed farmers represented the second largest segment (*n* = 117, 30.9%). They perceived all nine of the farming stressors as significantly more stressful, relative to the Non-stressed group. However, the main defining features of this segment were high pronounced concerns about the financial viability of their farms and weather, an important additional source of financial strain for many farmers. On average, Finance-stressed farmers scored higher than their Non-stressed counterparts on all three mental health outcome variables. However, the mean scores of all mental health outcomes for the Finance-stressed group fell within the normal range.

CSG-stressed farmers constituted the third largest segment (*n* = 58, 15.3%). Members of this segment were similar to the Non-stressed group in that, on average, they scored well below the midpoint on six of the nine farmer stressors. The main distinguishing feature of the CSG-stressed group was the elevated scores related to Off-farm and On-farm CSG Concerns. Clinically, the CSG-stressed segment fell just above the normal range for depression (M>9), and within the normal range for anxiety and stress reactivity.

The final segment consisted of Globally-stressed farmers (*n* = 55, 14.6%). Members of this segment reported inflated levels of stress across all but one of the farmer stress dimensions (Social Isolation), including mean scores for Off-farm and On-farm CSG Concerns that fell within the “high to very severe” range (*M* > 4.00). In terms of mental health, members of the Globally-stressed segment, on average, were characterized by “clinically significant” levels of psychological morbidity for depression (*M* > 9), anxiety (*M* > 7), and stress reactivity (*M* > 14).

Information about landholder engagement with the CSG industry, for each segment, is presented in Table 6. Examination of the adjusted standardized residuals from a contingency table revealed two statistically significant results: (1) farmers with no CSG leases were over-represented, relative to chance, in the in the Non-stressed segment; and (2) farmers who were currently engaged with the CSG industry (i.e., negotiating or in production) were over-represented in the CSG-stressed segment.

Table 2.6

CSG Industry Engagement within the Four Farming Stress Profiles

Notes: N = 378. Different subscripts (in rows) differ at $p < .05$. Z_{Resid} => is significant at $p < .05$. $^{***}p < .001$

Variables	Profile1: Non-stressed		Profile 2: Finance-stressed		Profile 3: CSG-stressed		Profile 4: Globally-stressed			Omnibus Significance Test
	Count	Z_{Resid}	Count	Z_{Resid}	Count	Z_{Resid}	Count	Z_{Resid}	Count (Total)	χ^2(df)
Engagement Status										
No Lease	83^{a} (66.4%)	4.9	30^{b} (24.0%)	-1.4	4^{c} (3.2%)	-3.5	8^{bc} (6.4%)	-2.4	125	χ^2 (9) = 114.27*** φ_c = 0.32
Lease –No approach	54^{ab} (34.9%)	-0.9	60^{b} (38.7%)	1.7	16^{a} (10.3%)	-1.6	25^{ab} (16.1%)	0.5	155	
Approach – Rejected	3^{a} (8.8%)	-2.8	11^{b} (32.4%)	0.1	10^{b} (29.4%)	2.1	10^{b} (29.4%)	2.3	34	
Engaged	8^{a} (12.5%)	-3.4	16^{ab} (25.0%)	-0.9	28^{c} (43.8%)	5.8	16^{b} (18.8%)	0.9	64	

4. Discussion

We investigated the association between a broad range of farmer stressors and mental health outcomes in a sample of Australian farmers. The Edinburgh Farming Stress Inventory (Deary et al., 1997) was adapted to include new items assessing concerns about CSG extraction in agricultural settings. The CSG items produced two new factors: Off-farm CSG and On-farm Concerns, the first of which explained a significant amount of unique variance in farmers' depression and stress reactivity after controlling for more traditional agricultural stressors. Finally, we created a typology of farmers based on their stress profiles and found two segments characterized by high levels of concern about CSG extraction, both of which exhibited clinically significant levels of psychological morbidity (i.e., symptoms of depression, anxiety and/or stress reactivity above the normal ranges of the DASS-42 norms). Each of these findings is discussed in more detail below, along with limitations of the study and suggestions for future research.

4.1 CSG as a Unique Farming Stressor

A central aim of this study was to determine if concerns about CSG extraction contributed to the overall stress burden for Australian farmers. We found that our sample distinguished between two main types of CSG-related stressors: (1) Off-farm CSG Concerns – potential impacts of CSG extraction on human health, community, and the environment; and (2) On-farm CSG Concerns – impacts of CSG on farm operations, profitability, and personal privacy. Concern about Off-farm CSG impacts were rated, along with Weather and Economic Viability, as the most stressful factor facing our sample of farmers. In contrast, concern about On-farm CSG impacts was rated as significantly less severe than six (Time Pressure, Bureaucracy, Weather, Economic Viability, Operational Debt, Off-farm CSG Concerns) of the other nine farm stressors assessed in the study.

Based on relative severity ratings, it appears that potential CSG impacts on health, community and environment were an important source of concern for farmers, whereas CSG impacts on farm operations, profitability and privacy were less of a concern. This interpretation receives further support when one considers the strength of the associations between the two types of CSG stressors and mental health. Farmers' concerns about off-farm (health, community and environmental) impacts of CSG extraction were significantly associated with increased symptoms of depression and stress reactivity after controlling for all other stressors assessed in the study. In contrast, On-farm CSG concerns failed to explain significant unique variance in any of the three mental health outcomes.

Our results linking CSG-related stressors to mental health are consistent with recent qualitative research on the arrival of mining and CSG industries in Australian rural communities, and their perceived impacts on mental health and well-being. Hossain et al. (2013, p. 32) concluded that the communities they investigated were "under sustained stress resulting from the incursion of mining and coal seam gas." Of the 12 communities surveyed, four listed mental health problems (including anxiety and depression) and lack of awareness of the link between farm-related stressors and mental health as major areas of concern. Our study extends these findings by identifying which specific aspects of CSG extraction are perceived as stressful, and how this new source of stress may exacerbate mental health problems in rural areas. From a methodological perspective, our findings suggested that traditional farm stress measures, such as the EFSI, can be usefully extended to incorporate reliable and valid indices of new forms of stress that may emerge in the farming sector due to new technological developments and incursions from other industries.

4.2 Farmer Stress Profiles

A second major aim of this study was to develop a new farmer stress typology, and determine whether unique segments emerged based on farmers' expressed concerns about

CSG extraction. We identified four unique farmer stress segments in our sample: Non-stressed, Finance-stressed, CSG-stressed, and Globally-stressed. We further sought to explore whether segment membership was significantly associated with mental health problems and also level of engagement with the CSG industry. Previous research into agricultural stressors has identified the need to tailor engagement strategies to the specific concerns of farmers (e.g., Alpass et al., 2004). The identification of farmer segments based on their reported levels of stress can facilitate effective tailoring and targeting of appropriate engagement strategies for both mental health professionals and industry. In this section, we discuss the defining characteristics of each segment and identify key issues for mental health and industry.

Members of the Non-stressed segment reported that they were generally unconcerned with any of the nine farmer stressors assessed in the study. Not surprisingly, members of this segment exhibited few signs of psychological morbidity; on average, their scores for depression, anxiety and stress reactivity all fell within the normal range. It is also worth noting that farmers who reported having no CSG lease entitlement over their properties were over-represented in this Non-stressed category. Given members of this segment appeared to exhibit sound mental health and managed properties unlikely to be directly affected by CSG extraction, we see no need to offer specific engagement advice for this group.

Members of the Finance-stressed segment were characterized by inflated concerns about weather and the economic viability of their farms. Their reported scores in all three mental health outcomes fell within the "normal" range. However, the stress reactivity for this segment, despite being in the normal range, was significantly higher than the levels reported in the Non-stressed segment. Extreme weather events, such as drought, adversely impact on-farm productivity and financial security, adding to the stress of those affected by it (Edwards, Gray, & Hunter, 2009; Gunn et al., 2012). While mental health intervention for members of this segment is not required, preventative actions through agencies such as the Rural Financial Counselling Service may prove beneficial (Department of Agriculture, 2015). The CSG industry should also be sensitive to farmers' financial concerns. Uniform and open compensation packages that help even out income streams during adverse weather events such as droughts and floods may assist in reducing financial stress.

The CSG-stressed segment was similar to that of the Non-stressed landholders in that the perceived severity of most of the traditional agricultural stressors was generally reported as low. However, stress associated with CSG impacts both on-farm (operations, profitability, and personal privacy) and off-farm (health, community and environmental) were assessed as severe; a key feature that sets this segment apart from the Non-stressed and Finance-stressed segments. Notably, the landholders with interaction with the CSG industry were highly represented in this segment; having either rejected an approach (approximately 30%) or engaged in lease arrangements (approximately 44%). Although direction of causation cannot be inferred from our data, it appears that active engagement with CSG activities – either positive or negative – appears to contribute to the stress burden of landholders. Our measures of On-farm and Off-farm CSG stressors highlight nine specific concerns that farmers have with the industry.

On average, depression scores for this segment reached clinically significant levels, at the lower end of the "mild" range. Anxiety and stress reactivity scores both fell within the normal range. However, like the Finance-stressed farmers, the average level of stress reactivity was significantly higher than the Non-stressed segment. Mental health service providers in rural Australia are well aware of the impacts traditional agricultural stressors have on farming communities. Our results suggest that, even in the absence of such traditional stressors, new stressors associated with emerging industries, such as CSG, may adversely affect farmers' mental health. Thus, the elevated symptoms of depression in this segment may reflect demoralization (feelings of uncertainty, helplessness or hopelessness) associated with these specific stressors. Accordingly, mental health practitioners working in rural areas should be alert to the possibility that CSG extraction may play a role in depression etiology, and provide interventions that improve coping responses and increase resilience. These could include problem-focused strategies (e.g., problem-solving and planning) to tackle issues that can be changed, and emotion-focused strategies (e.g., social support, regular exercise, and healthy emotional expression) to support mental health and well-being in the presence of an enduring stressor – in this case, CSG issues (WHO Collaborating Centre for Evidence in Mental Health Policy, 2004). CSG operators could assist in reducing the stress burden on famers by specifically addressing farmers' concerns during negotiation and operational stages.

The final segment, labelled Globally-stressed, comprised individuals who, on average, scored above the midpoint on all of the farmer stressors assessed in this study, with the exception of social isolation. The majority group (approximately 30%) was those who had rejected an approach by a CSG operator; therefore, not surprisingly Off-farm CSG concerns (health, community and environmental) was the predominant stressor. The segment exhibited levels of depression, anxiety and stress reactivity that fell above the normal range and at levels consistent with a mood or anxiety disorder. From a mental health perspective, this was the most worrisome segment. The results suggest the need for proactive identification and early intervention for farmers stressed by multiple factors, including unknown issues associated with the CSG industry. Community-based mental health first aid training, including knowledge about online resources such as Beyondblue (2014) and telephone counselling services such as Lifeline (Lifeline Australia, 2014) are front line strategies for reducing the potential morbidity of this group. However, given the risk of a persisting clinical response, services from mental health professionals are needed in local communities should a farmer or family member develop a major depressive disorder or other serious mental health condition. Such resources could be promoted and partially funded by the CSG industry, and provided by government and non-government health services, either in face-to-face or e-Health modes.

4.3 Limitations and Future Research

The study has several limitations. First, although we surveyed a large sample of farmers with different experiences with CSG extraction, we did not employ random sampling. Indeed, the 2011 Agricultural Census reports farmers are predominantly male (78%) (Australian Bureau of Statistics, 2012). Thus, our findings may not generalize to the Australian farming population. Nevertheless, this study clearly shows that a substantial number of Australian farmers are very concerned about CSG extraction in agricultural areas, and that these concerns are associated with a range of negative mental health outcomes.

Second, our cross-sectional correlational design prevented us from making strong inferences about causality and the directionality of effects reported in the study. Although several of the farmer stressors assessed in this study were significantly associated with farmer mental health status, it is unclear whether farmer stress dimensions are the primary driver of negative mental health outcomes. Other causal factors are probably operating, and it is also likely that psychological morbidity is exerting a reciprocal effect on farmer stress perceptions. Longitudinal studies are required to help clarify the precise nature of how the association between agricultural stressors and mental health develops over time, and the primary direction of causality. In terms of the potential impact of the CSG stress dimension on farmers’ mental health, future research should target soon-to-be developed agri-gas fields and monitor farmer stress and mental health as development progresses.

4.4 Conclusion

Farmers are subject to a broad range of occupation-specific stressors that can impact their mental health. We found that traditional models of farmer stressors can be usefully expanded to include concerns about CSG extraction. Farmers' CSG concerns related to community and health impacts explained unique variance in depression and stress reactivity after controlling for other common agricultural stressors. CSG concerns also played a central role in two of the four farmer stress profile segments identified in our sample. Both of these segments exhibited "clinically significant" levels of psychological morbidity, albeit in the low to moderate regions of severity. Insights about the association between CSG concerns and farmers' mental health may assist regulators and industry to review and adjust their practices to reduce unintended community impacts.

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