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Farmer welfare and animal welfare- Exploring the relationship between farmer's occupational well-being and stress, farm expansion and animal welfare

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A B S T R A C T

The aim of this paper is to explore whether and how dairy farmer's occupational well-being and stress are associated with animal welfare and farm expansion. A web-administered questionnaire was used to collect 914 dairy farmer's opinions on their quality of life, working situation and mental health. Factor analysis was used to describe farmer's occupational well-being and stress, and farmers who expand their farming operations. A structural equation model (SEM) was used to explore the association of the occupational well-being and stress with animal welfare. Animal welfare was measured by an animal welfare indicator, based on variables listed in the international standard that was available in the Norwegian Animal Recording System.

The findings show that high farmer occupational well-being and a low level of stress have a direct positive association with the animal welfare indicator. Contrary, low occupational well-being and high level of stress is negatively associated with the animal welfare indicator. Finally, farmer's degree of loneliness and optimism, satisfaction with income and determination to continue production, is associated with animal welfare indirectly through farm expansion. In this study farm expansion was positively associated with the animal welfare indicator.

1. Introduction

Animal welfare is a term used to express ethical concerns about the quality of life experienced by animals, particularly animals that are used by human beings in production agriculture (Duncan and Fraser, 1997; Fraser and Weary, 2004; Tannenbaum, 1991). Several studies have recognized the importance of farmer's managerial abilities, attitudes and behavior in dealing with animal health and welfare issues (Hansen et al., 2011; Vaarst and Tind Sørensen, 2009; Jansen et al., 2009; Kristensen and Enevoldsen, 2008). The characteristics of stockpeople that may influence the animal welfare standards include knowing and being skilled at the techniques they use, job motivation and satisfaction, and attitudes (Hemsworth and Coleman, 2009). We hypothesized that there is a relationship between farmers' occupational well-being and stress on one side, and how well they take care of their animals on the other. Building on a questionnaire to dairy farmers, and a newly developed prototype of an animal welfare indicator (AWI), we aim to explore this relationship. The AWI is developed using variables listed in the OIE (2016) standard available in the Norwegian Animal Recording System (Österås et al., 2007).

1.1. Literature on occupational well-being, stress and animal welfare

Job demand and job control are essential workplace characteristics which influences employee well-being, motivation, and productivity; as well as various physiological and psychological strains (Karasek, 1979). Thus, in a review Judge et al. (2001) found an average correlation between job satisfaction and productivity of 0.30, or moderate. Job demands include time pressure, exacting task requirements, and overall workload demands (De Jonge and Dormann, 2006). Perceptions of work stress relate to the perceived degree of "fit" between work demands and the availability of coping resources such as e.g. personal or work characteristics. Job control constitutes an individual's belief in his/her ability to affect a desired change on their work environment (Greenberger and Strasser, 1986). Control allows employees to change work processes to reduce the level of perceived stress. Events that have a stressing effect on humans are called stressors, and physiological and behavioral responses to stressors constitute strain, typically high levels of discomfort and exhaustion (Cooper et al., 2001). Strain is highest when job demands are high and job control is low.

Workplace support refers to helpful workplace relationships,

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generally with supervisors and coworkers, regarding job-related matters (Price, 1997). High levels of support are associated with increased well-being, whereas a perceived lack of support can be a catalyst for strain (Van der Doef and Maes, 1999; Häusser et al., 2010). Such support from colleagues may also make one perceive one's work more acceptable (Kaufmann and Kaufmann, 2009). Positive emotions increase an individuals' optimism, defined by Seligman (1998) as an attributional style that explains positive events in terms of personal, permanent, and pervasive causes and negative events in terms of external, temporary, and situation-specific ones. A pessimistic explanatory style does the opposite, thus undermining the favorable impact of successes and exacerbating the destructive potential of failures. Optimism has a positive effect on job satisfaction, job performance and work happiness (Youssef and Luthans, 2007).

Farming is considered a stressful occupation (McGregor et al., 1995), and stressed farmers are not coping well (Deary et al., 1997; Ang, 2010). Work- related stressors among farmers can be financial difficulties, lack of time, paper work and unfavorable weather (McGregor et al., 1995). Other significant sources of reported occupational stress have been overwork and labor shortage, the weather and adjusting to government regulations (Booth and Lloyd, 1999; Firth et al., 2006; Ang, 2010). Thus, increased work demands in Norwegian farming are associated with an increase in mental complaints among farmers (Logstein, 2016). Further, coping with new legislation and media criticism are also among stressors for farmers (Booth and Lloyd, 1999; Hansen, 2013) and family involvement in farming business, lack of understanding from outsiders, illness and not having enough time to spend with family are also among stressors reported (Fennell et al., 2016; Kearney et al., 2014). Some research has also stressed the importance of loneliness and geographical isolation as sources of stress in farming (Eberhardt and Pooyan, 1990; Judd et al., 2006). Interestingly, having close friends was associated with better mental health among Norwegian male farmers (Logstein, 2016). Finally, how farmers cope with stress varies.

The following definition of animal welfare endorsed by the World Organization for Animal Health (OIE) in 2008 emphasizes the role of management and handling:

'An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy,

comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering

from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, *management,* nutrition, *humane handling* and humane slaughter/killing (the author's highlights). Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment.'

Stockmanship has been described as a "human activity that applies the ability, knowledge, skills and common sense necessary in optimizing health, welfare, husbandry, management, and thereby both physical and financial performance, in animal production" (Benyon, 1991).

The UK Farm Animal Welfare Council (2007) acknowledges stockmanship as the single most important influence on farm animal welfare and have proposed three attributes they call the 'Three Essentials of Stockmanship', namely knowledge and skills in animal husbandry, and personal qualities (ibid.). The latter attribute is described as '*affinity and empathy with animals, dedication and patience*' (ibid.). The skills, knowledge and motivation of stockpeople to effectively care for and manage their animals are integral to animal welfare (Hemsworth, 2018). Several studies have demonstrated a sequential relationship between the stockperson's attitudes and behaviour, and the animals' levels of fear, productivity, health and welfare (e.g. Hemsworth et al., 2000; Waiblinger et al., 2002; Nawroth, 2017; Ivemeyer et al., 2018). Further, a recent Canadian study show associations between on-farm welfare indicators and productivity and profitability (Villetaz Robichaud et al., 2019).

Our knowledge of the relationship between farmer welfare and animal welfare is limited. In this paper the aim is to explore the relationship between the AWI and farmers' occupational well- being and stress. Further, we aim to explore how dairy farmers' experienced degree of loneliness, satisfaction with income, optimism and their decision to keep up production influences their decision to expand farming. Finally, we aim to explore how farm expansion (FE) affects the AWI. In Norway, all cowsheds built after 2004 must be free- stalls, to allow cattle to practice the five freedoms. We present the following hypotheses:

Hypothesis 1. A high level of farmer occupational well-being (FOW) and a low level of farmers stress (FS) has a positive effect on the AWI, and contrary.

Hypothesis 2. A positive relationship exists between farmers occupational wellbeing, their decision to continue production and their decision to expand farming, and FE has a positive impact on the AWI.

2. Materials and methods

2.1. The Norwegian context

Compared with the early 1960s, Norwegian agriculture is now much more specialized and mechanized, and it is characterized by increased production, efficiency and workload (Almås, 2002). Most farms continue to be family owned and operated businesses, while some joint farming operations exist. In European context Norwegian agriculture is small-scale. The average farm unit runs around 22 ha, and the average herd size is approximately 27 cows. Only 3 percent of the dairy farms have more than 70 cows (Budget Committee for Agriculture, 2017). To understand why this structure prevails it is necessary to be aware that the average piece of land is one hectare, and agricultural land may be rather scattered. In 2017 approximately 22 percent of the dairy farms in Norway had an automatic milking system (AMS) (Hettasch, 2019).

2.2. The AWI

The variables included in the AWI are shown in Tables 1 and further details are in Table 2. The variables in Table 1 are picked from the list of variables relevant for assessing animal welfare in dairy cattle according to OIE (2016). All variables included in AWI were available from the Norwegian Animal Recording and extracted from the database. In 2017, 97.1 percent of the dairy herds were member of the animal recording. The AWI was calculated for each herd with data from each of the years 2015, 2016, and 2017. In this paper only 2017 was used. The total AWI is the sum of all the indicators presented in Table 1 as indicated by the calculations. As baseline year 2015 was used, so all figures in the table are herd means and standard deviation from 2015. Finally, all part indicators (milk yield indicator, life indicator etc.) are adjusted so the part indicator for 2015 was 0.0. The total sum of AWI is then added by 100, such that the mean for 2015 was 100.0. The mean for 2017 was 101.5 with a STD of 10.6. As the AWI was adjusted to 100 in 2015 this shows a slight improvement of the AWI from 2015 to 2017 by 1.5 points.

Each variable is assigned a value between -3 and 3, where 3 represents the highest level of welfare. Discrete variables like use of a certified claw-trimmer or not, and classification of carcasses are simply assigned a number. Other variables are calculated based on a normalized standard deviation. For continuous variables, deviations from the mean are applied. For discrete variables the Poisson distribution is applied as in the following example: In a herd of 75 cows, the herd recordings show 20 treatments for a disease in one year. The country

Table 1
Detailed overview over variables used to calculate the AWI.

Variable	Used mean value	Used STD	Calculations	Chosen values[3]
Milk yield indicator				
305 days milk yield in 2nd parity minus 1st parity	980	990	NSTDcont[1]	−3;3
305 days milk yield in 3rd parity minus 2nd parity	515	1015	NSTDcont[1]	−3;3
305 days milk yield in 3rd parity minus 1st parity	1491	1059	NSTDcont[1]	−3;3
Life indicator				
Proportion of cows culled the first 14 days in milk	0.064		NSTDpoi[2]	−3;3
Culled cows between 84 and 290 days in diagnosed pregnant cows	0.10		NSTDpoi[2]	−3;3
Culled inseminated/mated cows between 84 and 290 days without pregnancy test[4]	0.11		NSTDpoi[2]	−3;3
Replacement rate (proportion of 1st parity cows)	0.36	0.133	NSTDcont[1]	−3;3
Length of life for cows after 2nd parturition (days)	680	283	NSTDcont[1]	−3;3
Metabolic indicator				
Number of milk fever after 2nd parity	0.0779		NSTDpoi[2]	−3;3
Number of ketosis of all cows	0.0373		NSTDpoi[2]	−3;3
Number of thin cows (BCS < 2.75)	0.0427		NSTDpoi[2]	−3;3
Number of thick cows (BCS > 3.75)	0.1748		NSTDpoi[2]	−3;3
Variation of BCS (STD)	0.419	0.123	NSTDcont[1]	−3;3
Carcass weight cows in kg	269	30	NSTDcont[1]	−3;3
Meat classification young cows			See Table 2	
Meat classification cows			See Table 2	
Carcass weight young cows	254	28	NSTDcont[1]	−3;3
Fat classification young cows			See Table 2	
Fat classification cows			See Table 2	
Udder health indicator				
Number of cow cell counts > 200,000 pr. ml	0.2013		NSTDpoi[2]	−3;3[5]
Cases of clinical mastitis	0.22395		NSTDpoi[2]	−3;3[5]
Number of cows culled due to bad udder health	0.0247		NSTDpoi[2]	−3;3
Fertility indicator				
Number of days from average last insemination till first insemination for each cow	27.5	24.2	NSTDcont[1]	−3;3
Average calving interval in months	12.7	1.37	NSTDcont[1]	−3;3
Number of cows culled due to bad fertility	0.1339		NSTDpoi[2]	−3;3
Young stock indicator				
Number of dead young stock	0.01652		NSTDpoi[2]	−3;3
Number of emergency-slaughtered young stock	0.001779		NSTDpoi[2]	−3;3
Number of euthanized young stock	0.003706		NSTDpoi[2]	−3;3
Number of treated young stock	0.0222		NSTDpoi[2]	−3;3
Carcass weight heifers, kg	218	38	NSTDcont[1]	−3;3
Growth rate heifers (gram per day)	342	57	NSTDcont[1]	−3;3
Carcass weight young bull kg	297	46	NSTDcont[1]	−3;3
Growth rate young bull (gram per day)	523	81	NSTDcont[1]	−3;3
Carcass weight young cow kg	254	28	NSTDcont[1]	−3;3
Growth rate young cow (gram per day)	214	31	NSTDcont[1]	−3;3
Age in months at first calving	25.8	2.2337	NSTDcont[1]	−3;3
Dehorning indicator				
Number of dehorning after 42 days of life	0.35		NSTDpoi[2]	−3;3
Number of dehorning after 70 days of life	0.10		NSTDpoi[2]	−3;3
Number of calves with horn	0.76		NSTDpoi[2]	−3;3
Dead cow indicator				
Dead cows	0.0247		NSTDpoi[2]	−3;3
Cows emergency slaughtered	0.01028		NSTDpoi[2]	−3;3
Cows euthanized	0.00743		NSTDpoi[2]	−3;3
Calves indicator (until 180 days in life)				
Dead calves	0.08		NSTDpoi[2]	−3;3[6]
Treated calves	0.064		NSTDpoi[2]	−3;3[6]
Claw indicator				
Number of claw diagnosis with pain[7]	0.12		NSTDpoi[2]	−3;3
Professionality of claw trimming[8]				−3;3
Number of trimmed cows	0.67		NSTDpoi[2]	−3;3

[1] Normalized standard deviation for continuous variables = (observed value - mean value)/STD.
[2] Normalized standard deviation for Poisson distributed variables = (possible numbers x 0.064 minus observed numbers)/(possible numbers x 0.064)ˆ0.5.
[3] If NSTDcont or NSTDpoi > 3 then set to 3; if NSTDcont or NSTDpoi < -3 then set to -3.
[4] This variable is weighted by 0.5.
[5] If NSTDpoi for cases of clinical mastitis > 0 and NSTDpoi for number of cow cell count > 200,000 per ml < 0 then NSTDpoi for mastitis is multiplied with -1.
[6] If NSTDpoi for dead calves < 0 and STDpoi for treated calves > 0 then STDpoi for treated calves are multiplied with -1.
[7] Diagnosis with pain is defined as: Digital dermatitis, Lameness, Sole ulcers, White line fissure and White line abscess.
[8] Sum of proportion of claw trimmed by professional claw trimmer x 0.3 and proportion of claw trimmed by uncertified claw trimmer x 0.2 and proportion of claw trimmed by owner x 0.1 all divided by 10.

average for the same year and disease is 0.15 treatments per cow. Expected number of cows treated based on the country average then becomes $0.15 \cdot 75 = 11.25$. The standard deviation of the expected value is $\sqrt{11.25} = 3.35$, and the deviation from the country average becomes $11.25 - 20 = -8.75$. The number of normalized standard deviations for this variable is $\frac{-8.75}{3.35} = -2.61$. The final value is set to -2.61, because it signals a negative effect on animal welfare. Contrary, only two treatments per year for the same illness would have yielded a positive value of 2.76. Extreme numbers below -3 or above 3 are set to -3 and 3 respectively.

Table 2
Scoring according to fat and carcass classification.

Variable	Class	Score
Average carcass meat classification, cows and young cows	Poor minus_1	−1
	Poor_2	−1
	Poor plus_3	−1
Average carcass fat classification, cows and young cows	Low minus_1	−3
	Low_2	−3
	Low Plus_3	−2.5
	Slight minus 4	−2
	Slight_5	−1
	Slight_6	0.5
	Average minus_7	2
	Average_8	3
	Average Plus_9	1
	High minus_10	−0.5
	High_11	−1
	High plus_12	−2
	Very high minus_14	−2.5
	Very high_14	−3
	Very high plus_15	−3

For further details about the AWI we refer to Table 1.

As should be clear by now, the AWI does not aim to capture all aspects of animal welfare. Thus, natural behavior and positive welfare indicators like play or grazing are not included. The AWI is validated against such variables at some farms. Four experienced veterinarians skilled in animal health and welfare judgement evaluated 39 herds by the indicators not present in the AWI. Beforehand the veterinarians were given a spreadsheet with the variables to be judged. They did not know the indicator beforehand, and judged several factors like: laying behavior, fearfulness of cows, access to water, dirty animals, injured or bruised hocks, necks and fore-knees, use of birth pens, social interaction by calves, milk feeding by calves, claw status, concentrate feeding, pasture practices, feed access and soft bedding in their evaluation. Finally, they assigned each farm a score between 0 and 10, where 10 represented the best animal welfare judgement

The scores associated with fat and carcass classification are in Table 2.

2.3. Questionnaire

Participants in this study responded to a web- administered questionnaire to 3400 dairy farmers late autumn 2017. Data were collected for a larger study about AMS. The aim of the study was to explore how farmers perceive their quality of life, their working situation and mental health, the future of their farm, work division between family members, income etc. To compare farmers with and without AMS, the questionnaire was distributed to all 1700 farmers registered with an AMS autumn 2017, and to 1700 randomly selected dairy farmers with conventional milking systems.

2.4. Factor analysis

Factor analysis is a common statistical method used to find a small set of unobserved variables, also called factors, which can account for the covariance among a larger set of observed variables. In this paper we apply factor analysis to examine the covariation among a set of observed variables about the farmers and farming to gather information on the variable's underlying latent constructs or factors. In models, factors are typically embraced by circles, and here they are written in capital letters. In factor analysis one almost always assumes that the latent variables "cause" the observed variables, typically shown by single headed arrows pointing away from the factor and towards the observed variables. Item variances and covariances are usually shown to the left of the items with single and double headed arrows respectively. Mathematically, the basic idea of factor analysis is the following: For a given set of observed response variables or items $x_1,\ldots., x_p$ one wants to find a set of underlying factors $\xi_1,\ldots, \xi_k$, much fewer than the observed variables. These factors are supposed to account for the correlations of the response variables in the following way (Thurstone, 1947):

$x_i = \mu_i + \lambda_{i1}\xi_1 + \ldots\ldots + \lambda_{ik}\xi_k + \delta_i$, $i = 1, 2,\ldots, p$, where δ_i, the measurement error for x_i , is uncorrelated with $\xi_1,\ldots., \xi_k$ and with δ_j for $j \neq i$ (Jöreskog et al., 2016). Further, Var $(\delta_i) = \sigma_i^2$ and E $(\delta_i) = 0$. Given the factor, the observed variables are independent of one another, Cov$(x_i, x_j\,|\xi) = 0$. This means that the x' s are only related to each other through their common relationship with ξ. Thus, the correlation between x_i and x_j, corr $(x_i, x_j) = \lambda_i\lambda_j$. For a standardized x_i , corr $(\xi, x_i) = \lambda_i$. The objective of factor analysis is to estimate the number of factors k and the factor loadings $\lambda_{i1},\ldots, \lambda_{ik}$. Factor loadings are equivalent to the correlation between factors and variables when only a single common factor is involved. If x_i is N (0,1), then λ_i is equivalent to the correlation between x_i and λ_i. Thus, understanding the structure and meaning of an unobserved or latent variable in the context of its' manifest variables is the main goal of factor analysis.

A confirmatory factor analysis (CFA) begins by defining the latent variable one wants to measure (Jöreskog et al., 2016), based on theory and previous knowledge. The CFA is statistically estimated to obtain the factor loadings and tested. We used the latent variables from the CFA as predictors of the AWI in structural equation models (SEM) (ibid.). A SEM is an extension of the classical factor analysis where the goal is to use the factors themselves as predictors or outcome variables in further analyses. A SEM specifically expresses the effect of latent variables on each other and the effect of latent variables on observed variables like the AWI. For readers unfamiliar to factor analysis we refer to Jöreskog et al. (2016) for an overview.

The factor FOW includes four items; I am satisfied with my working day (Satisfied), I have an income I can live well with (Income), I have an optimistic view about the future (Optimism) and I feel appreciated as a farmer (Appreciated). The factor FS includes three items which describe how farmers have felt over the last six months; I have often been stressed due to work (Stressed), I have often felt lonely (Lonely) and I have often felt weary (Weary). Similarly, the factor FE includes the following items; Construction year cowshed (Construction); Percentage milk production increase the last ten years (Increase), and Quota size (Quota). For the items Satisfied, Income, Optimism, Appreciated, Stressed, Weary and Lonely respondents were asked to mark on a Likert scale ranging from 0 to 10 whether they agreed or disagreed with the different claims raised. For Construction the respondents were asked what year the cowshed was built or substantially renewed. For Increase the respondents were asked to mark on a six-point scale by how many percent they had reduced or expanded milk production during the last ten years. The alternatives were: Reduced production, Increased production by; 0–29%, 30–49%, 50–69%, 70–99% and above 100% respectively. For Quota the data were collected from Tine's advisory department. Tine is the dominating Norwegian dairy company and is owned by Norwegian dairy farmers in cooperation. Tine also has an advisory department offering services to farmers, e.g. on animal health. The variable Continue was collected with a four-point scale where farmers were asked how likely it is that they will continue to produce milk over the next five to ten years. Lonely, Income and Optimism in our model of FOW and FS also serve as explanatory variables in the FE model. The mean and standard deviations of the items and the explanatory variables are given in Table 3.

In the analysis, all items except Quota were coded as ordinal variables. Quota and the AWI were coded as continuous variables. The AWI is a continuous variable with a mean of 104.181 and a standard deviation of 11.244, ranging from 72 to 132. The higher the AWI, the better the animal welfare. To analyze the data, we applied the lavaan-package in the statistical software R (CRAN, 2018). Following the

Table 3
Mean and standard deviations of the items and the explanatory variables in the study (N = 914).

Items and variables	Mean	Std.dev.	Range
I am satisfied with my working day	7.633	2.243	1–10
I have an income I can live well with	6.511	2.477	1–10
I have an optimistic view about the future	7.633	2.243	1–10
I feel appreciated as a farmer	6.365	2.829	1–10
I have often been stressed due to work	4.699	2.541	1–10
I have often felt weary	4.499	2.456	1–10
I have often felt lonely as a farmer	6.199	2.958	1–10
Construction year cowshed	1996	17.339	1913–2016
Production increase	2.663	1.712	1–6
Quota size	270 537	160 540	33562–900000
I consider quitting milk production 5–10 years ahead'	1.710	1.058	1–4

'a high number indicates a high probability of quitting milk production.

recommendation of Jöreskog et al. (2016), we applied the diagonally weighted least squares (DWLS) estimator for polychoric correlation matrices.

To answer Hypothesis 1 we used a SEM including the two factors FOW and FS together with the AWI. The factors were regressed on the AWI. In the SEM we opened for covariances between Satisfied and Optimism, Optimism and Income, and Stressed and Weary because it improved the overall model fit. To answer Hypothesis 2 we also used a SEM, including the factor FE and a set of explanatory variables including Lonely, Optimism, Income and Continue to explain the variation of the factor. FE was then regressed on the AWI.

3. Results

The overall response rate of the AMS-survey was 38%. The AWI was available for only 914 of these respondents, 54% of which have an AMS, more than twice the national average. Focusing on these 914 farmers we merged the AWI with the data from the AMS- survey. In total 774 of the farmers are men and 140 are women. Their age ranges from 22 to 78 years, with a mean of 48. The average milk quota for the farms in the study was 270 537 liters, while the national average was 186 788 (Norwegian Agriculture Agency, 2019). Only 34 of the farms were run organic, and other family members took part in the farm work on 80 percent of the farms. The AWI has a mean of 104.2, slightly better than the country mean, and a standard deviation of 11.2, ranging from 72 to 132. In the 39 validated herds there was a correlation between the calculated AWI and the score of the veterinarians of 2.69, with a P-value of 0.006, and a coefficient of determination of 0.19.

A test of all items for skewness and kurtosis showed that all values are within +/- 2, which is considered acceptable to prove normal univariate distribution (Gravetter and Wallnau, 2014). Similarly, tests of multivariate skewness and kurtosis (Mardia, 1970) revealed no signs of significant deviations from normality. The Spearman rank correlation coefficients between the items and the AWI are in Table 4.

All correlations except two between the AWI and each of the items are significant, as are all correlations between the items. In social science studies like this, correlations above 0.4 are generally considered to be relatively strong, correlations between 0.2 and 0.4 are moderate, while those below 0.2 are considered weak (Shortell, 2001). Thus, most correlations between the items are moderate, while some are relatively strong. In general, the correlations between each of the items and the AWI are weak, which illustrates that no single item alone can account for the variation in the AWI. The items need to be put together in factors or constructs to become efficient.

The path diagram for FOW, FS and the AWI is in Fig. 1.

All factor loadings are significant and beyond 0.5, which indicates a strong loading (Costello and Osborne, 2005). The theoretical model provides a good fit to the observed data with a Chi- square value of 24.155 on 15 df ($p = 0.063$). Other indices ($0.000 \le RMSEA = 0.026 < 0.044$, SRMR = 0.029, NFI = 0.988, CFI = 0.995) also point to a good model fit. The reliability composite measures are 0.679 for FOW and 0.685 for FS, and Cronbach's alpha 0.712 and 0.736 respectively. Both measures indicate that the items included in each factor are reliable measures of the constructs. In accordance with Hypothesis 1 FOW has a positive association with the AWI, while FS has a negative association. The calculated relationships between the two factors and the AWI are moderate.

The correlations between the three items, the explanatory variables and the AWI in the FE model are in Table 5.

In Table 5 we can see that all correlations are significant, and the signs are as expected given that high values of Continue represents a high probability of quitting milk production. We notice the negative correlation between considering quitting milk production and animal welfare. The correlations between construction year, production increase and quota size and the AWI are moderate, while the remaining correlations with the AWI are weak.

The path diagram for FE, the explanatory variables and the AWI is in Fig. 2.

All factor loadings are significant and beyond 0.5. The theoretical model provides a good fit to the observed data with a Chi- square value of 11.241 on 14 df ($p = 0.667$). Other indices ($0.000 < RMSEA = 0.000 < 0.026$, SRMR = 0.018, NFI = 0.992, CFI = 1.000) also point to a good model fit. The reliability composite measure is 0.689, and Cronbach's alpha 0.733. Both measures indicate that the items included in the factor are reliable measures of the construct. The standardized path coefficient for FE on AWI and the coefficient for quitting milk production is moderate, while the coefficients for the explanatory variables are weak. The findings support Hypothesis 2.

4. Discussion

How farmers thrive at work is pivotal to productivity and to keep up dairy farming. Our findings in Fig. 1 show that there is a positive relationship between FOW and the AWI, and a negative relationship between FS and the AWI. Albeit moderate, the strengths of the relationships are within the range frequently found in a studies of job satisfaction and stress versus job performance (Judge et al., 2001). Further, the FE model in Fig. 2 shows that farmers who expand their

Table 4
Spearman rank correlation coefficients between the seven items in the model of farmers' occupational wellbeing and farmer stress, and the AWI (N = 914).

Item	Satisfied	Income	Optimism	Appreciated	Stressed	Weary	Lonely	AWI
Satisfied		.32***	.51***	.23***	−.28***	−.37***	−.34***	.07*
Income			.36***	.28***	−.20***	−.26***	−.21***	.10**
Optimism				.36***	−.22***	−.33***	−.38***	.13***
Appreciated					.21***	−.23***	−.32***	.09*
Stressed						.57***	.44***	−.04
Weary							.44***	−.01
Lonely								−.07*

* $p \le 0.05$* $p \le 0.01$ ** $p \le 0.001$***.

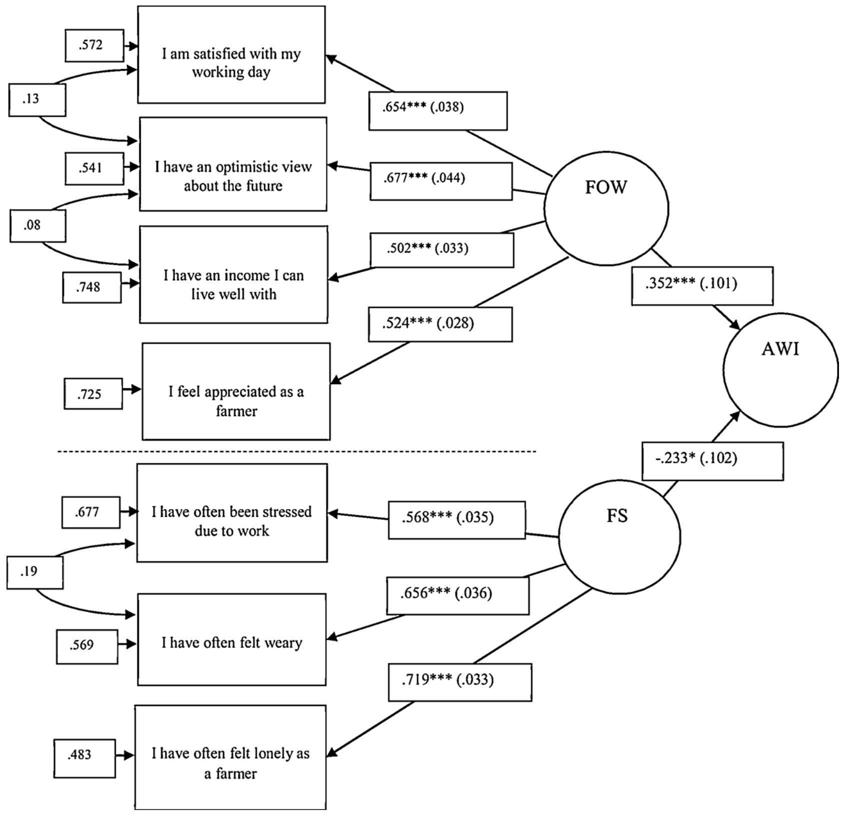

Fig. 1. Path diagram for the SEM with the following variables from left to right: covariances, measurement errors, standardized factor loadings with standard errors, and the standardized path coefficient with standard errors between FOW, FS and the AWI.
* p ≤ 0.05 ** p ≤ 0.01 *** p ≤ 0.001.

production are more satisfied with their working day and income, more optimistic and more determined to continue production than those who do not expand. Further, FE has a significant positive association with the AWI.

According to Muri (2012) many previous studies of the relationship between farm animals and farmers rest on farmer's attitudes and behaviors. Thus, the theory of planned behavior (Ajzen, 1985) is frequently applied (ibid.). To the best of our knowledge few studies have explored the relationship between FOW, FS and measures of animal welfare. Therefore, while several studies have demonstrated the importance of the stockperson's attitudes and behavior on animal welfare (e.g. Hemsworth et al., 2000; Waiblinger et al., 2002; Ivemeyer et al., 2018), our study contributes by offering possible explanations of the different attitudes, behaviors and management practices reported in literature. Identifying these causes of different behaviors and attitudes is pivotal to be able to affect them. Thus, our study provides a starting point for the dairy industry and other stakeholders in targeting intervention strategies and services to improve both farmer- and animal welfare. To be able to offer the animals good welfare, the farmers themselves must thrive at work. Therefore, farm advisors, veterinarians and other professionals visiting the farm need to pay attention to both the animals and the humans responsible for taking care of them. Thus, our findings may be of use in designing preventive mental health efforts in the dairy industry.

Our finding that a feeling of loneliness is associated with an increase in FS underlines the importance of social networks among farmers, as a source of both social and professional support, in line with Hansen (2013). Lack of support in the daily work can be a catalyst for strain and may also make farmers perceive their work less acceptable. This may reduce FOW and increase FS. Further, lack of social capital reduces transfer of knowledge and innovation and diffusion of new technology and practices. Poor farm economy represents another stressor which may reduce farmers coping abilities and their feeling of job control. First, poor farm economy may be an effective barrier for FE. Second, strained economy may also reduce farmer's willingness to participate in preventive health measures and may also imply too little use of veterinary services. This can affect animal welfare negatively.

The findings that insufficient income, lack of social support and feeling lonely represent stressors which causes strain and can influence animal welfare negatively, are in line with (McGregor et al., 1995;

Table 5
Spearman rank correlation coefficients between the four explanatory variables, the three items and the AWI in the FE model (N = 914).

Item/ variable	Lonely	Optimism	Income	Continue	Construction	Increase	Quota	AWI
Lonely		−.38***	−.21***	−.24***	.14***	.12***	−.21***	.07*
Optimism			.36***	−.31***	.26*	.17***	.25***	.13***
Income				−.10**	.13***	.07*	.21***	.10**
Continue					.33***	−.26***	.28***	.19***
Construction						.49***	.56***	.25***
Increase							.52***	.21***
Quota								.28***

* p ≤ 0.05* p ≤ 0.01 ** p ≤ 0.001***.

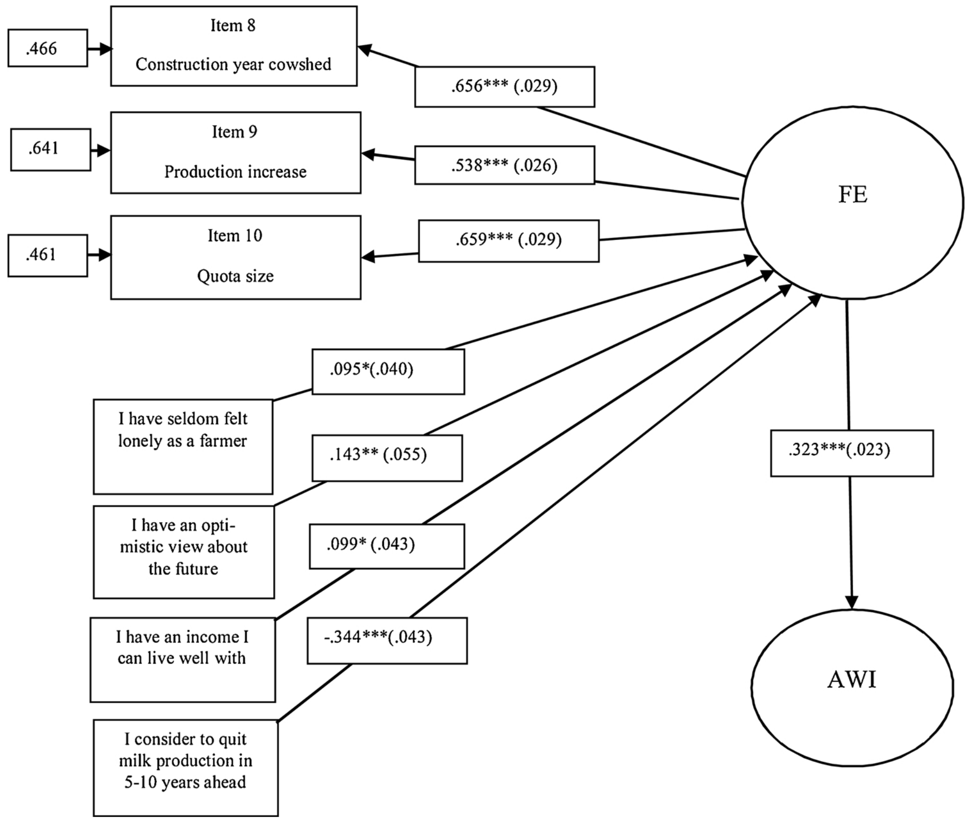

Fig. 2. Path diagram for the SEM with the following variables from left to right: measurement errors, regression coefficients with standard errors, standardized factor loadings with standard errors, and the standardized path coefficient between FE and the AWI with measurement error.
*$p \leq 0.05$ ** $p \leq 0.01$ *** $p \leq 0.001$.

Booth and Lloyd, 1999; Fennell et al., 2016; Häusser et al., 2010 and Van der Doef and Maes, 1999). Optimism is an explanatory variable in both models. This underlines its' importance in relation to animal welfare both directly and indirectly. Our finding that optimism has a positive effect on work performance and outcome are in line with Youssef and Luthans (2007) and Seligman (1998). For example, the degree of optimism may determine farmer's willingness to participate in animal welfare assurance schemes and voluntary disease control programs. Contrary, pessimistic farmers may think they have little effect. Pessimism also leads farmers to explain negative events in terms of personal, permanent, and pervasive causes. This reduces their degree of perceived job control, which reduces the farmer's problem-solving abilities related to disease prevention and treatment. Their belief in their ability to affect a desired change is reduced. Thus, pessimistic farmers may think their efforts will not help. Finally, pessimistic farmers may also be less eager to take on FE. The way the Continue variable is coded, the negative correlation with Optimism suggests that a high level of optimism is associated with a low willingness to continue farming. Similarly, the negative correlation between Continue and the AWI suggests that considering quitting milk production may reduce animal welfare. Finally, a low FOW and a high level of FS is likely to result in less proactive behavior, and thus less interest in management practices such as planning in general (Hansen, 2013). Taken together, FOW and FS may influence management practices considered pivotal for animal welfare, such as record-keeping related to health, and the use of appropriate plans for feeding, production, health and welfare.

FOW and FS may influence on farmer's empathy, willingness and time spent to inspect the animals, and thus their ability to recognize and deal with pain and suffering. FOW and FS may also influence their patience with the animals, and lack of patience may reduce the important habituation to human contact, c.f. (Boivin et al., 2003). However, the effect may go both ways. Thus, having a good health status and a high AWI may also contribute to a high FOW and a low FS, and a higher probability of FE. Taken together our results suggest that when farmers' perceived degree of fit between the work demand and the availability of coping resources comes out of balance, this may have a negative impact on animal welfare both directly and indirectly.

In future the animal welfare indicator should be further developed and refined to better reflect important aspects of animal welfare. Resting exclusively on herd recordings, the AWI does not aim to be a complete expression of the animal welfare at individual farms. Thus, natural behavior and positive welfare indicators like play or grazing are not included. To assess animal welfare more thoroughly one should always supplement the AWI with a farm visit. However, such farm visits with a personal judgement on animal welfare also would tend to be subjective according to the visitors' experience and skill. Thus, it is interesting to find a significant association between the veterinarians and the AWI in the 39 validated herds. The present AWI needs further validation to be improved as an indicator. Therefore, care must be taken when interpreting the results, and this represents a weakness of our study. However, due to the high number of farms in this study, and that the AWI rests on the international standard from OIE, we think the use of the AWI for our purpose is defendable.

Elaborating on this study, future studies could explore the relationship between animal welfare, FOW and FS more in depth. One avenue could be to include questions which can uncover specific mental health states such as fatigue and depression, or empathy, considered a crucial component of good stockmanship (English, 1991). Future studies could also include farm visits and interviews with farmers to get an impression of how farmer's well-being relates to work performance, and how farmers cope with stress. Further, the link between several elements of the AWI and farm economics could encourage scholars to explore the relationship between the animal welfare and farm economy. Although evidence exists that the sources of FOW and FS vary little with milking system (Hansen and Sträte, in progress) and Hansen (in progress), future studies could also explore a sample more in line with the average national milk quota and frequency of AMS. This would make it easier to generalize the results to all Norwegian dairy farmers.

5. Conclusions

A link exists between farmer's occupational well-being, farmer stress and animal welfare measured by the animal welfare index. The findings suggest that higher the occupational well-being and the lower the farmer stress, the better the animal welfare. Further, farmer's degree of loneliness and satisfaction with income, and farmer's optimism together with a determination to continue production, are also associated with the animal welfare index indirectly through farm expansion. In this study farm expansion has a positive association with the animal welfare index.

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Declaration of Competing Interest

None.

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