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Application of the Work Assessment Method (WAM) on Australian dairy farms: implications for future research

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Abstract: *The importance of improved social sustainability in farming for attracting and retaining a farm workforce, including family and non-family participants, has brought renewed focus amongst farmers, advisors and researchers to the analysis of farm work and farm work organisation. In the context of Australia's large-scale farming however, there has been less attention in research to changes in farm work and work organisation, in particular those changes associated with an increase in non-family members as employees or contractors and the implications for work organisation from introduction of farm technologies. The aim of this paper is to report on a pilot study on Australian dairy farms of the application of a work assessment method (WAM) developed in France, to consider the efficacy of the method for the Australian context, adaptations that may be required, and the potential application of WAM in future research. Drawing on the experiences of the authors and results from a WAM analysis of two pilot dairy farms in north-east Victoria, we found the WAM identified labor efficiencies on the farms, helped identify practical solutions to workload issues and assisted the farmers in (1) clarifying their priorities in the organisation of work for social sustainability and (2) assessing the value of technology options from a workforce perspective. We identified five areas for improvement in the WAM for the Australian context and use in research: the definition of the basic group; the task categories and terminology for routine and seasonal work; the methods for documenting routine work for a "typical day"; the principles underpinning the Calculated Time Available metric, and; the need for greater alignment between the WAM and farm financial analysis. Further, the inclusion of additional measures of the quality and well-being impact of work tasks such as the timing or stress involved in tasks, may enhance the analytical power of the method. Further research is needed to test the recommended adaptations to the WAM method for larger scale livestock systems.*

Keywords; *farming systems analysis, labour, technology, Work Assessment Method*

Introduction

The organisation of farm work has become an important consideration for farmers, advisors and researchers with many farms now relying on contractors and non-family employees for farm work (Nettle *et al.,* 2018b; Nye, 2018; Malanski *et al.,* 2019), with uncertainties regarding the role of automation in replacing or augmenting the farm workforce (Eastwood *et al.,* 2017) and with reports of labour shortages and challenges in staff recruitment and retention (Ferris *et al.,* 2006; Nye, 2018; Dockès *et al,.* 2019; Dufty *et al.,* 2019; Malanski *et al.,* 2019). Further, farmers' social expectations of farming work and life have also changed, with a heightened focus on improved work conditions and a work-life balance that has more time for leisure and family (Couzy and Dockes, 2008; Madelrieux and Dedieu, 2008; Romera *et al,.* 2020).

In order to understand these changing dynamics in the farm workforce and to support decision making in addressing workforce challenges, techniques have emerged within farming systems analysis to assess farm work organisation (Madelrieux and Dedieu, 2008). Farm work organisation refers to the logic and patterns of interaction between the work that needs to be done and the people who do the work, placed in the context of the other non-farm activities of the farm family. It is usually the case that any change made to the farming system will have implications for farm work including its rhythm (*e.g.* seasonality of tasks), duration, the types of tasks and the skills required. These methods of work assessment consider the implications of changes in the farm system for farm work inclusive of the extra resources that are needed to manage work, how new innovations or strategies compete with existing

ones, and how fulfilling or arduous new tasks might be. Farm work assessment complements consideration of the technical and financial dimensions of any change proposal (Delecourt *et al.,* 2019). The Work Assessment Method (WAM) (*Bilan travail* in French) is a research and advisory tool developed by INRA and the French Livestock Institute (Idele) for analysing work organisation on livestock farms (Madelrieux and Dedieu, 2008). The method has been in use in France since the 1990s, and has also been used in other countries including Belgium, Uruguay, Brazil, Vietnam and Morocco (Cournut *et al.,* 2018). While analysis of work organisation has been developed over many years for livestock production systems, Australia's large scale farms have not featured in the application of such methods in farming system analysis, despite the importance of working conditions and farmers' perceived quality of life being raised as an issue for the social sustainability in Australian farming (Dumont and Baret 2017; Janker and Mann, 2018; Nettle *et al.,* 2018b; Janker *et al.,* 2019; Janker, 2020). The only metrics related to farm work that are in common use in Australia are total labour cost and cows milked per full-time worker (Dairy Australia, 2017). The WAM then, offers a way of analysing and thinking about farm work that is different from other methods currently in use in Australia. However, the differences in Australian farming systems, including the typically larger size of Australian farms and their associated larger and more complex workforces, may create difficulty for conducting a WAM analysis, and create a need to adapt the method for the Australian context. This paper aims to address the research question: To what extent does the Work Assessment Method (WAM) assist in analysis of farming systems related to improving farm liveability and social sustainability on Australian dairy farms?
The next section introduces the Australian dairy sector context for the research and the concepts of work assessment before describing the research approach.

Australian farming systems

Despite their large scale in terms of hectares, most of Australia's 132,000 farms are family farms (Dufty *et al.*, 2019). Australian agriculture employs less than 3% of the employed population, however the changes in the social organisation of family farms has created a diversity of workforce categories (casual, contract, overseas workers) whereby some Australian agricultural sectors report up to a third of their farm workforce as casual, including those employed on working holiday visas. Further, 69% of Australian farms use contractors to undertake a range of farming operations (Nettle *et al.,* 2018a). In the dairy sector, the average herd size of dairy farms is now more than 260 cows per farm and as a result, the number of dairy farms operated by a single person, or with a partner, has fallen steadily from 43% in 2007 to 28% in 2013 (Dairy Australia, 2013). Involvement of farm family members in off-farm paid work is also steadily increasing. This move from an owner-operator based sector to a sector employing a range of people has provided new challenges in terms of staff recruitment, deployment and retention and has necessitated a change in how farmers design and implement their farming systems. Farmers, advisors and farming system researchers in Australia seek ways to analyse farm workforce organisation to understand and consider alternative workforce strategies, including the role of new farm techologies in labour replacement.
For the purposes of this paper it is also important to consider the physical arrangements of Australian dairy farming systems, and their implications for farm work. Aside from their typically larger size (in hectares, in cows and in workforce), a further key difference is that cows graze outdoors throughout the year. The work associated with housed cows (feeding; cleaning; changing the litter) is absent. Dairy farmers in Australia are also typically dairy specialists: They may grow some crops to harvest as hay, silage or for grain feed, but typically do not grow crops for external sale. It is also uncommon for dairy

farmers to graze additional species such as sheep or goats. Many farmers irrigate part of their pasture and/or fodder cropping areas. Milk harvesting is usually in herring-bone or rotary dairy sheds, with milking robots uncommon.

Challenges in the application of the WAM in larger farm contexts have been noted in comparative cross-country studies (Cournut *et al.*, 2018). This includes accounting for work delegated to farm managers or work-teams, accounting for the variation in categories of labour and accounting for the increased labour time in management-related work (*e.g.* supervision and administration). The study of the application of WAM in the larger farm context of Australia can therefore provide an important contribution to these issues.

The Work Assessment Method (WAM)

Based on data collected in a structured interview with the farmer, the WAM enables the development of an annual calendar of farm work, identifying different types of work based on their temporal characteristics, and identifying also the different types of people who contribute to the work. The main concepts in the WAM are described in Madelrieux and Dedieu (2008) and include:

- *Routine, seasonal work:* Tasks done in the farm system. 'Routine Work' must be done daily or on a regular basis and is difficult to postpone. This includes routine animal care and feeding and, in the case of dairy farms, milking, and is measured in hours per day. 'Seasonal Work' involves tasks that are easier to postpone or concentrate, and include hay making, sowing, or fencing and is measured in half-days within each fortnight period of the calendar year.
- *Work periods:* The year is divided into a series of work periods, within which the pattern and quantity of routine work is similar. These periods are unique to every farm and are identified as part of the data collection process.
- *People:* The people who contribute to the farm work are divided into the Basic Group (BG), and other categories of workers including employees, mutual assistance, contractors and volunteers. Madelrieux and Dedieu (2008) define the Basic Group as "the workers of the farm engaged in the farm work, its organisation, for whom we need to take into account their expectations in terms of quality of life, to know the combinations of activities – economic and private – to understand the work organisation on the farm".

Utilising these concepts and definitions, the WAM translates the farm's technical calendar of herd and land management practices into a calendar combining tasks and workers. There are three levels of analysis:

1. Calculation of the work time required to operate the farm system, divided into different categories of routine and seasonal work tasks.
2. Characterisation of how the work is organised: how much of each category of task is done by which type of worker, at what time.
3. Efficiency and social sustainability indicators: the hours of routine work per livestock unit, or days of seasonal work per hectare of agricultural area, and indicators of flexibility or the autonomy of the Basic Group for both routine and seasonal work (calculated as the percentage of total work in these categories that is performed by the Basic Group), and the Calculated Time Available (CTA) or "room to manoeuvre" that is available to the members of the farm's Basic Group and is the time remaining once all routine and seasonal work has been accounted for. The calculation procedure for CTA is described in Cournut *et al.* (2018).

Methodology

In 2018, the authors collaborated to carry out the first Australian trial of the WAM, on two dairy farms. Both farms belong to the Mountain Milk Cooperative located in the north-east part of the state of Victoria. Both farms are owned and operated by a single nuclear family involving a farming couple and young children who do not contribute to farm work. Table 1 provides a physical description of the two pilot study farms.

Item	Farm 1	Farm 2
Total farm workforce (people)[1], (fte[2])	5, 4.1	5, 3.6
Usable area[3] (ha)	389	500
Milking area[4] (ha)	230	300
Milking herd (no. of cows)	390	360
Milk production (L/cow), ('000 L/year)	8270, 3225	8333, 3000
Cows/fte	95	100
Litres/fte ('000)	790	833

Table 1. Pilot farm physical, workforce and production data. *1. Includes the farmer (Farm 1) and farming couple (Farm 2). 2. fte = "full-time equivalent". This is standard terminology to describe jobs and employment conditions in Australia in all industries, including agriculture. A "full-time equivalent worker" notionally works 38 hours per week or 1800 hours per year. In reality, many salaried (as opposed to waged) workers work more hours than this, but they are still referred to as "full-time workers". Employment conditions for workers who are employed on a specified part-time basis are often expressed as a decimal fraction of "full-time equivalent". For example, a worker may be employed in a part-time position described as "0.6fte", which is notionally 22.8 hours per week. But, as with full-time workers, if employed on a salary, the worker may work a greater number of hours than this in some weeks. The "fte" figure in the table is the sum of the work fractions, as specified in employment conditions, for all the workers on the farm, including the farm owners. 3. The total area available for farming operations, including areas not accessible to the milking herd. This includes areas for grazing young stock or for cropping operations. 4. The area available for grazing by the milking herd.*

Data collection via a structured interview took place simultaneously on both farms on 13 December 2018. A French researcher accompanied the Australian researchers at each interview. On both farms there was one (male) member of the farming couple who is primarily responsible for day-to-day management of the farm and it is this person – referred to henceforth as "the farmer" – who participated in the interview. The interviews took approximately 3 hours. One week after the interviews, after completion of preliminary data analysis, farmers provided feedback on: the extent to which they thought the results provided an accurate reflection of their situation, the usefulness of the analysis to their farm decision-making, ideas for improving the usefulness of the method for farm decision making and impressions on the usefulness of the method for other farmers and for dairy farm system analysis more broadly.

Results

A full report of results of the pilot study can be found in Santhanam-Martin *et al.* (2019). Here, we summarise the main results, to discuss the implications for future development of the WAM in the Australian context and in future research.

Summary of Work Assessment results on the pilot farms

Workforce, goals of work organisation, work periods and the routine and seasonal work on the pilot farms

• Farm 1. On Farm 1 the farmer's spouse has an off-farm job and makes no regular contribution to farm work, hence the farm has a Basic Group of 1 (the farmer alone). The balance of the farm workforce is made up of four employees who between them work 3.1 full-time equivalent positions (3.1fte), as per Table 1. The farmer was restructuring the farm workforce and modifying the farm's work organisation when the WAM data were collected and identified the following key questions and areas for improvement where he hoped the WAM analysis could assist: (1) farmer seeking more free time (reduced total work), (2) seeking ways to reduce staff work hours to less than 50 hours/week[1], and (3) he was considering several new equipment and technology investments, and was interested in further insight on which would be most useful for improving the farm work situation. The farming year was divided into five work periods (Table 2). Total routine was 8,040 hours per year, of which the farmer himself contributed 31% (Table 3). This amounts to 6.9 hrs/day on average, across the full 365 days in a calendar year.

Farm 1		Farm 2	
Period	**Description**	**Period**	**Description**
1 Mar – 15 May	Autumn calving	16 Dec – 28 Feb	Silage feeding
16 May – 31 Jul	Autumn joining	1 Mar – 15 Jun	Autumn calving + feeding out
1 Aug – 15 Oct	Spring calving	16 Jun – 31 Jul	Autumn calving
16 Oct – 31 Dec	Spring joining	1 Aug – 15 Dec	Spring calving
1 Jan – 28 Feb	Summer irrigation		

Table 2: Work periods on the pilot farms.

• Farm 2**.** On Farm 2, the farmer's spouse does some farm work, with the amount varying with changing routine work requirements through the year, and thus it is appropriate to include the spouse in the Basic Group. However, she is not available to do farm work full time and so was included as 0.3fte, giving a total size of the Basic Group of 1.3. (Standard practice in WAM is to include all members of the Basic Group as 1 and hence this farm would have a basic group of 2. However, following this practice would significantly increase the assumed total work hours available to the Basic Group and hence increase the Calculated Time Available metric in a way that is inconsistent with the lived reality of work organisation on the farm). The balance of the farm workforce is made up of three employees who together work 2.3fte. On Farm 2, the year was divided into four work periods (Table 2). The farmer identified the following key questions and areas for improvement: (1) Farmer feeling time pressure throughout the year – seeking more time off, (2) Can more tasks also be delegated? (3) Need to provide more autonomy for staff and (4) Concern the farm will be overstaffed if more permanent employees are added. Total routine work was 8,860 hours per year, of which the farmer himself contributed 25% (Table 3). This amounts to 5.7 hours per day across 365 days.

[1] Standard full-time working hours are 38 hours/week as noted above. However, employers can request employees to work additional hours (if not unreasonable) and additional hours can be paid at higher rates of pay. Averaging of weekly work hours to comply with the 38 hours/week rule is also possible.

Farm	Farm 1		Farm 2	
Routine Work	Total Routine Work	8,040 hours/year 22 hours/day[1]	Total Routine Work	8,860 hours/year 24 hours/day
	Farmer (31%)	2,520 hours/year 6.9 hours/day	Farmer (25%)	2,080 hours/year 5.7 hours/day
			Spouse (11%)	950 hours/year 2.6 hours/day
	Employees (69%)	1,780 hours/fte.year 4.9 hours/fte.day	Employees (64%)	2,450 hours/fte.year 6.7 hours/fte.day
	RW/cow	21 hours	RW/cow	25 hours
	RW/1000 litres	2.5 hours	RW/1000 litres	3.0 hours
Seasonal work	Total Seasonal Work	66 days/year	Total seasonal work	191 days/year
	Farmer (39%)	25.5 days	Farmer (58%)	111 days
	Employees (36%)	24 days	Employees + Contractors (42%)	80 days
	Contractors (25%)	16.5 days		
	SW/usable area	0.2 days/ha	SW/usable area	0.4 days/ha
	SW/milking area	0.3 days/ha	SW/milking area	0.6 days/ha

Table 3. Total Routine work (RW) and Seasonal work (SW) on the pilot farms. *Notes: 1. Averaged across 365 days.*

Work organisation analysis on the pilot farms

The allocation of routine work between tasks on the pilot farms is shown in Figure 1 and the temporal pattern of routine and seasonal work is shown in Figure 2.
On Farm 1 the task categories “Milking” and “Care for dairy cattle” accounted for the largest portion of the routine work. The amount of routine work was highest in the two joining periods (Autumn and Spring), and lowest during summer. The seasonal work totalled 66 days/year distributed between the farmer, employees and contractors (Table 3). This includes seasonal work associated with animal care and with crop and pasture management. Figure 2 also shows periods of high combined SW & RW in Autumn and Spring. Seasonal work is much less during winter.
On Farm 2 milking and feeding were the largest categories of routine work (Figure 1). Routine work was highest in autumn due to the combination of joining and silage feeding (Figure 2). Routine work was lowest in summer, as it was for Farm 1. Seasonal work totalled 191 days/year for Farm 2. Figure 2 again shows peaks in total work (RW + SW) in autumn and spring.

Calculated time available on the pilot farms

Total CTA for Farm 1 (basic group = 1.0) was calculated as 405 hours, with the temporal distribution shown in Figure 3. According to the CTA calculation, the farmer has no additional time available (no “room to manoeuvre”) after completing all routine and seasonal work requirements, from mid-May until the end of July and again mid-October until the end of December. This result confirms the farmer’s experience of being under severe time pressure for much of the year. While the CTA is higher in January and February (due to lower routine work demands at this time) the farmer commented that seasonal work at this time included attending to his irrigation system, which required him to be awake several times each night. He reported feeling less flexibility and “room to manoeuvre” at this time than the CTA

calculation suggests. On Farm 2, the Calculated Time Available for the Basic Group is 511 hours (with the size of the basic group set as 1.3, as discussed above). The temporal distribution (Fig. 2.) shows that the farming couple have zero CTA (no "room to manoeuvre") from the beginning of March until the middle of June.

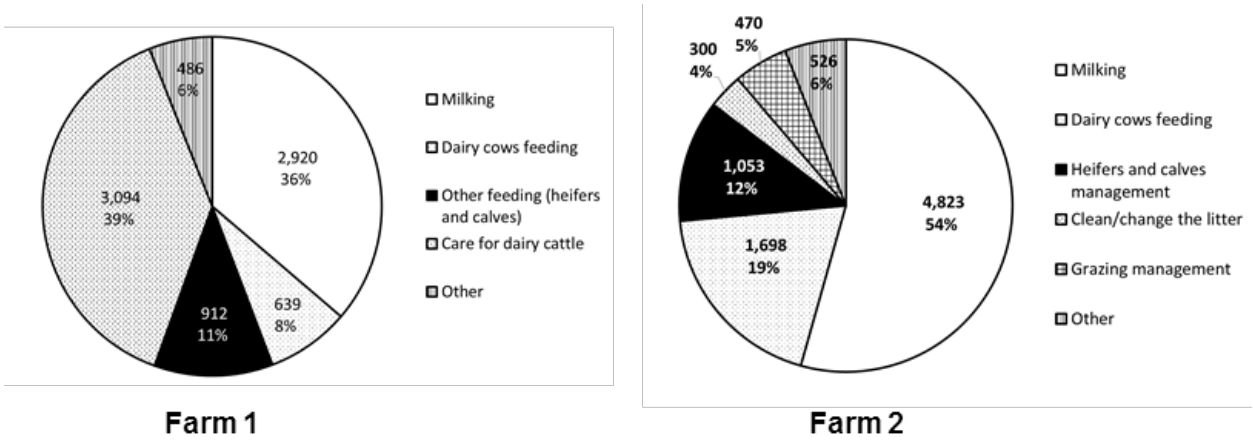

Figure 1. Distribution of routine work hours between task categories (total yearly hours and %).

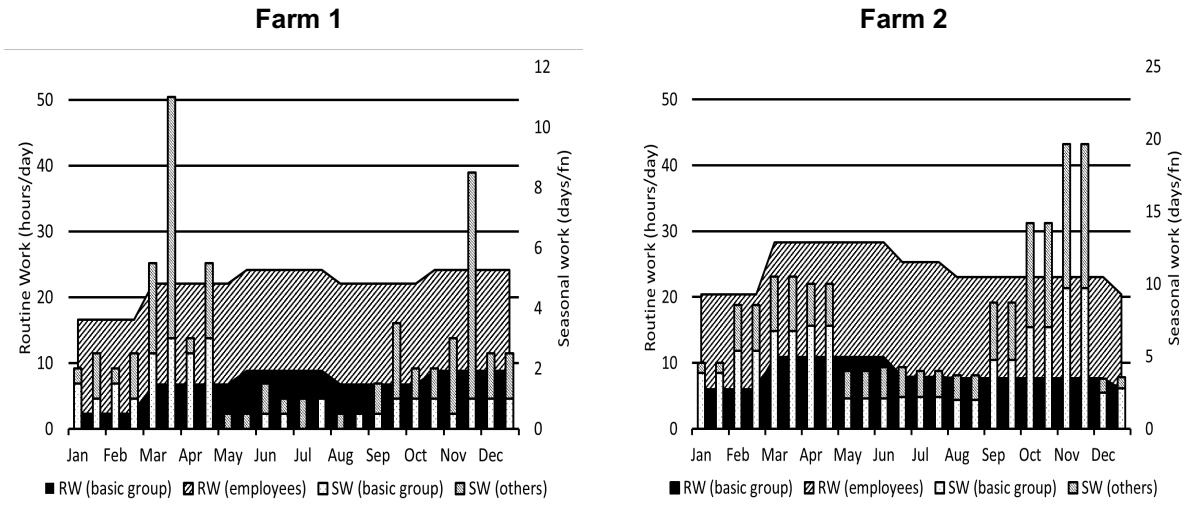

Figure 2. Annual distribution of routine work (RW) and seasonal work (SW) on the pilot farms.

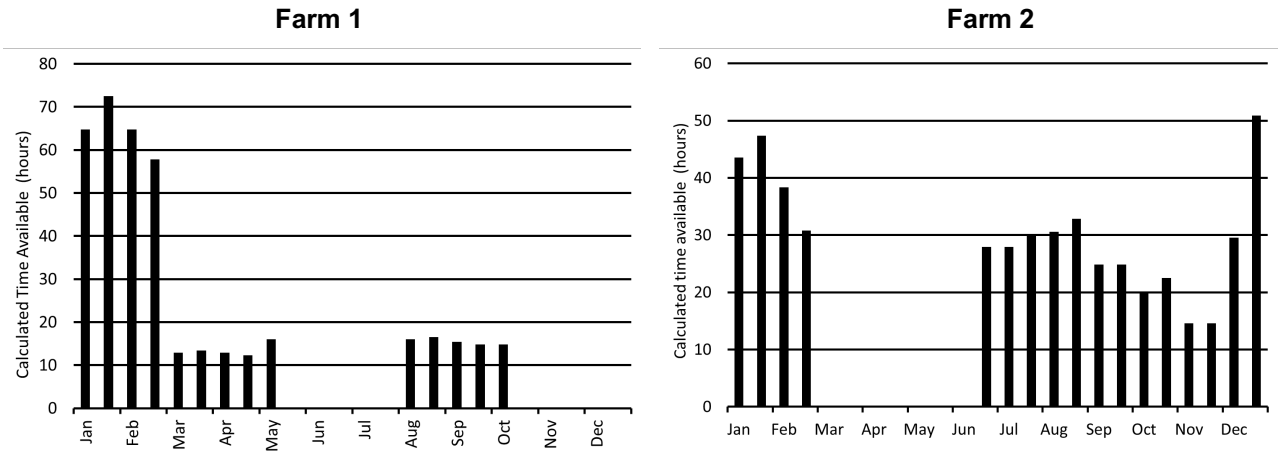

Figure 3. Calculate Time Available (CTA) on the 2 pilot farms – fortnightly basis, per member of the Basic Group.

Discussion of the WAM analysis with pilot farms

Analysis of the farm metrics relating to routine farm work (*i.e.* between 21-25 hours per cow on both farms) represents good efficiency when considering comparative results on French farms (Fagon and Sabatte, 2010). The routine work analysis on Farm 1 revealed that the farmer is spending considerable time on the task category "care for dairy cattle". This includes monitoring cow's health as they come through the dairy, and also heat detection. For Farm 2, the seasonal peak of routine work extends over many months. The low CTA on both farms indicates that to achieve the goals of reducing the farmers' and the employees' working hours an increase in labour supply (that is, an increase in the farms' workforces) will be needed. While the CTA analysis on Farm 1 showed the farmer having more time available during January and February, this is the irrigation season when he has to be awake several times during the night to move sprinklers. The time involved in this work is not great, but it is tiring due to sleep disruption. The calculated CTA does not adequately represent the demands of this work. The low CTA on Farm 2 confirmed the pressure on this farmer and suggests the initial concern of overstaffing was over-stated.

The WAM analysis suggests the following actions relating to the farmers' goals for improvement:

Farm 1: Examine opportunities to reduce work associated with 'cow care', for example technologies that reduce work such as electronic collars for cow monitoring. Alternatively (or as well), examine opportunities to delegate more responsibility to employees, or engage more casual staff to reduce the farmers' total workload. The benefits and costs of irrigation automation could be explored further to reduce the sleep deprivation experienced in the irrigation season, and constructing a feed pad close to the dairy to assist with monitoring of cows and reduce time spent travelling to paddocks could be explored.

Farm 2: Could consider more milking relief to reduce the farmer's Routine Work (*e.g.* 3 days/fortnight). Outsourcing more of the seasonal work to contractors to reduce the farmer's seasonal work load, or delegating more responsibility to an employee to oversee the casual staff, could provide more free time for the owner, however this also highlights the need to account for time spent on staff supervision within the routine work assessment, as discussed below.

Discussion

The application of the WAM to analyse two pilot farms assisted the analysis of work organisation on farms related to farm liveability and social sustainability, assisted with identifying options for addressing challenges in work (as identified by farmers) and assisted in assessing the potential benefits for work organisation from alternative technologies. The study also revealed areas for further enhancement and development of the work assessment method for the Australian context and areas for consideration for future research. The areas for enhancement involve:

1. Defining the Basic Group: The Basic Group are the workers for whom agricultural work predominates in time and income (Cournut *et al.* 2018). In the Method, the main reason to distinguish the Basic Group from other workers is to calculate the time available (CTA) per member of the basic group. This is an important aspect of farm work organisation to capture, since overwork is a common source of dissatisfaction for livestock farmers, including in Australia (Eastwood *et al.*, 2018). In defining the basic group, the key question is thus: for whom do we wish to assess flexibility or room to manouvre? Is it only for the farm owner, or in some cases should it also include senior staff? We suggest that for larger farms with senior staff in managerial positions it may be appropriate to include these staff in the Basic Group, since the social sustainability and liveability of the farm for these workers is important for their well being and for retention in their jobs (Nettle 2015). Another criteria for inclusion could involve discussing, from the farmer's perspective, the extent to which the work of senior staff is interchangeable with the work that they do themselves. If the farmer is able to delegate managerial work to senior staff so as to increase their own time available then it is logical to include such staff in the Basic Group. This suggested approach is a departure from the application of WAM in some countries whereby the delegation of work from a farm owner to a foreman was represented as 0 (zero) for the Basic Group (Cournut *et al.*, 2018). Ultimately the decision of who to include in the Basic Group is one for the farmer and the analyst to make together, depending on the objective of the analysis.

*2. Task categories and definitions for routine and seasonal work: W*e found that the definitions and categories of routine work tasks were different between the two pilot farms, and hence the distribution of routine work between tasks cannot be directly compared. For example, on Farm 2 cow care activities that take place in the dairy were included in the "milking" category, whereas on Farm 1 they were included separately as "Care for dairy cattle". This was partly because we used English translations of the French interview guide and data analysis tools. For example, it isn't necessary to include task categories related to housed cows, and agreement is needed on what specific tasks should be included in the category of "care for cows". We also suggest that on large farms it may be necessary to include "staff management" as a category of routine work, since this can occupy considerable time. This has been noted as an important consideration for improvement in WAM (Cournut *et al.*, 2018). With respect to seasonal work, measuring seasonal work in half-days within each fortnight may not be the best approach for Australia due to the extensive use of large-scale contractors who often complete work such as sowing, spraying or harvesting in tightly-specified durations that are less than half a day. Measuring seasonal work in hours therefore requires further consideration[2]. Overall, consistent definitions and

[2] French WAM practitioners have trialled collection of seasonal work in hours but found that farmers often reported benchmark figures for how long they thought the work should take (*e.g.* one hour per hectare for sowing) rather than reporting the hours actually worked.

categories will make data collection during the farm interviews clearer, simpler and make results between farms more readily comparable.

4. *Documenting routine work for a "typical day" on a farm:* Both interview teams experienced some difficulty collecting the routine work data. This was because the farms had multiple employees working on a roster system and hence there are different individuals present on the farm on different days. This makes it difficult to describe a "typical day" with individual workers assigned to tasks. On Farm 1, the tasks involved and duration of routine work on typical day were described broadly, without always specifying which worker was doing the work, since that changes according to the work roster. However, the routine work done by the farmer did follow a consistent daily pattern in each work period, and was able to be specified separately from employees' work. The experience from Farm 1 suggests it is to best to begin the discussion of routine work by looking at the farm's roster system before then deciding how to proceed with the data collection. This approach may go some way toward addressing the call for wider consideration of 'work teams' in the description and analysis of work tasks (Cournut *et al.*, 2018). This approach however creates additional complexity for designing the data collection and analysis tools, for research purposes, which ideally require data in standard formats that can be compared between farms.
5.

4. Calculated Time Available: The Calculated Time Available concept is crucial to understand the social sustainability of farm systems. The method used to calculate CTA involves assumptions about what time is potentially available for farm work (Cournut *et al.,* 2018). In particular, it assumes a standard 8-hour work day and 6-day week. The method does not assume that farmers never work more than eight hours per day. Rather, the CTA procedure assumes that on any day when the farmer works more than eight hours, they lack additional "room to manœuvre", to take on additional farm work or other non-farm activities. Further,the CTA is intended to be used as a relative measure, for making comparisons, and not as an absolute measure. Nevertheless, if the WAM is going to be used more widely in Australia, it will be important to decide what assumptions should be built into the CTA calculation, and as Cournut *et al.* (2018) argued, the values of those assumptions will differ with farmer expectations. It will be important for research purposes to adopt a consistent calculation procedure, and to be cognisant of the implications for international comparisons if there is a departure from international practice. The CTA has been further criticized as being an indicator of buffering capacity in work-time rather than as a real measure of flexibility or adaptability in the farming system (Cournut *et al.,* 2018). In our study, the discussion of the WAM results with farmers identified potential sources of flexibility and adaptability in their farming system. Further research should examine options to build from the CTA to better identify sources of flexibility and adaptability.

5. Compatibility with financial and benchmarking programs already in-use: Where possible, the concepts and terminology used in the WAM should be aligned with standardized financial and farm performance benchmarking programs in use in different industries such as DairyBase (Dairy Australia 2017), to assist in achieving consistency in the way the tool is used. This will assist with integrating assessment of farm work organisation into industry's overall approach to farming system analysis and reporting which can strengthen the applicability of other research on the technical and financial aspects of change proposals (*e.g.* Edwards 2020; Henty *et al.,* 2020) as well as in the assessment of new technologies (Hostiou *et al.,* 2017).

In addition to these areas of the WAM, our analysis of the pilot farms and subsequent discussion with farmers has highlighted areas for further development of the WAM in research. While relevant solutions to workload pressures can be identified through the WAM analysis, such as increasing the use of casual workers or delegating responsibilities to current employees, these changes also impact on the position descriptions, skills, salary levels and work contracts of existing employees, and have implications for the management of employees and the employment management skills of the owner/employer. These human resource management implications of changes identified in the WAM require greater consideration in the development of recommendations for farmers and also in comparative research (Nettle 2015). Secondly, while the WAM accounts for the impact of working time and work duration through the CTA, the WAM analysis doesn't necessarily account for the psycho-emotional and psycho-social dimensions of the timing or nature of tasks on well-being, such as the non-standard work hours of irrigation on Farm 1. The job demands and stresses of certain tasks and their timing requires consideration in work assessment, such as through job satisfaction and engagement indices (Bakker and Demerouti 2007) which relate to the concepts of job quality and decent work (ILO 2020).
We acknowledge the small number of case farms is a limitation in drawing wider conclusions for the development of the method and applicability of the method in Australia and recommend further research including further piloting of the method, to test the recommended adaptations to the WAM method for larger scale livestock systems.

Conclusion

The WAM provides a way of evaluating and thinking about the pressure and high workload that farm owner-operators experience,and situating this within an understanding of the whole farm system. It reveals the workload of the owner-operator in a way that standard farm economic and technical analyses do not. This is an important new perspective to bring to Australian livestock farming at a time when the sustainability of farming for farmers and their families is becoming increasingly important. A second potential contribution of the WAM is to assist with the evaluation of new technologies. The WAM provides a more detailed representation of the work involved in different areas of the farm, and of who currently does this work, and this can be used to assess in more detail what benefits a new technology offers. The WAM can enhance the utility of existing farming system modelling approaches by representing farm work in a more sophisticated way, and by introducing an indicator of farm liveability for the farm family. It can also be used to explore the implications for farm work of proposed farming system changes.
The suggested adaptations proposed to WAM would enable wider use of the WAM in large-scale farming systems, particularly if also supported by digital platforms to assist with the compilation and reporting of data. This would enable further exploration of research questions related to different work organisation strategies and their drivers and consequences. For example, how does use of contracted services vary between farms? and is there a typology of different approaches that farmers use to divide work between family and employed workers, and between permanent and seasonal workers? To this end, we recommend further development of the WAM for larger scale livestock farming systems such as in Australia. This further development should be carried out by researchers working collaboratively with farmers and advisors so that their complementary knowledge of the farming system, and the differing potential uses of the method, are reflected.

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