Evaluating the role of forage shrubs in filling feed gaps - application of a feed demand tool

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Abstract
Perennial forage shrubs offer benefits to mixed farming systems in the low rainfall zone of southern Australia including providing out of season or drought forage on marginal farming areas, year round ground cover and water management. The key benefit for many farmers is filling the annual feed gaps of a predominantly annual based feed system. There have been research and extension efforts focused on understanding, promoting and supporting the adoption of perennial forage shrubs in the low rainfall zones of south eastern Australia. Despite this, existing feed base decision support tools aimed at farmers and advisors did not include forage shrubs. An existing whole farm planning tool (the MLA Feed Demand Calculator) has been expanded using trial and simulation data to include a forage shrub option and 8 new location options. The tool is applied to a mixed farm case study in the low rainfall zone of Victoria where the role of an area of saltbush in meeting autumn and pre-crop harvest feed demand is evaluated. It offers farmers and advisors a relatively simple to use tool to consider the role of forage shrubs in the whole farm feed base context.

Keywords
Saltbush, *Atriplex,* Feed Demand Calculator, EverCrop.

Introduction
The use of perennial forage shrubs is valuable in mixed farming systems as they produce green forage that is available at times of the year when livestock feed gaps frequently occur. Although often only occupying less than 10% of the farm area, whole farm modelling has shown that plantings targeted at less productive soils may increase potential profit on mixed farms when considered at the whole-farm level (Monjardino et al. 2014). Other benefits include shelter for livestock, year-round ground cover, a feed supply during times of drought, and a management option for soil water management and areas affected by salinity (Harris et al. 2008; Norman 2012).

There has been an investment in research and extension activities focused on understating and developing perennial forage shrubs for mixed-farming systems in the low-medium rainfall zone of southern Australia through the EverCrop (e.g. Descheemaeker et al. 2014) and Enrich programs (Revell et al. 2013). These activities have included species evaluation, understanding the management and economics of farming systems that include forage shrubs, and extending research outcomes to mixed-famers in the low rainfall zones.

The Feed Demand Calculator (FDC) developed by Meat and Livestock Australia is a valuable decision support tool that is able to help farmers understand the availability of various sources of forage over the whole farm feed base in relation to the demand by the livestock enterprise (Bell et al. 2008). The FDC has been used as one component in a continuum of tools that allow farmers to understand their current system and explore alternatives. Owing to its origins, the FDC was focused towards grazing systems in medium to high rainfall zones, as such forage shrubs were not included in the original versions. Extending the FDC to include forage shrubs and an increase in the range of low rainfall locations expands the potential applicability and value of this established tool. In this paper the modifications to the FDC are described as well as its application to case study farms with a large cropping program where the current role of forage shrubs in filling specific feed gaps is identified.

Methods
Development
The FDC is based on the balance of energy between the supply from various forage sources such as pastures,

crop stubble, standing crop, supplementary fed, and the demand by livestock in their various states (i.e. sex, reproductive status, age). A negative energy balance at any period in the year is identified as a feed gap. For the low rainfall zone, the development of the FDC necessitated the compilation of data on the long term average dry matter production of pastures and forage shrubs. Old Man Saltbush (*Atriplex nummularia* Lind.) is one of the most widely utilised forage shrubs in this zone, and hence was selected for inclusion in this new version of the expanded FDC.

For forage shrubs, monthly dry matter was simulated using the saltbush model in the APSIM framework (Descheemaeker et al. 2014) for a number of key locations which were representative of the regions they are within. These new regions and locations included:
NSW – Central West (Narromine)
NSW – Central West (Condobolin)
NSW – Central West (Hillston)
NSW – South West (Hay)
VIC – Mallee (Carwarp)
SA – Mallee (Waikerie)
SA – Mid North (Morchard)
WA – Eastern wheat belt (Merredin)

The model was setup using local climatic and soil conditions for each site and the forage shrubs were moderately spaced plantations (i.e. 900 stems/ha) with no interrow simulated. In the model, the metabolisable energy of the forage material is not calculated explicitly, so following Monjardino et al. (2014) a constant value of 8 MJ metabolisable energy per kg edible DM was applied for all locations, stages of defoliation and times of year. Long term (i.e. 60-year) averages to 2013 model runs were determined, using annual resets for soil organic matter pools and water.

For pastures the task of developing long term average ME was more difficult as there is a dearth of experimental information on pasture growth rates or dry matter production for the low rainfall zone. Additionally, this zone is marked by large climatic variability which creates large variations in the availability of metabolisable energy from pastures within and between years. Data from weekly LandSat Thematic Mapper images was gathered and then interpolated for weekly growth rates using a simple plant model based on temperature. As above, metabolisable energy was applied across the dataset. This data was checked for credibility and realism by and experienced agronomists familiar with the region.

Testing

The expanded FDC was tested in three ways to determine if the results generated were a reasonable representation of the environment. The first step was to run the model with mock farm data to determine whether the calculator produced outcomes in-line with expectations for an average season for the chosen location and pasture type. The second step involved the application of the model. This was undertaken through the development of three case studies in low rainfall mixed farming situations. Sitting alongside the farmer to populate the model provided end-user feedback, and where required improvements to the spreadsheet were made. Importantly, this step provided further checks to ensure the expanded Feed Demand Calculator was accurately representing the expected pasture growth in an average season at three different low rainfall environments. The third step involved presenting case study examples of the model to grower groups made up of both farmers and consultants. Again, this ensured the outputs from the expanded FDC were in line with expected pasture growth for the environment.

Results

Testing of the expanded Feed Demand Calculator

Using real time farm data a case study was developed for a mixed-farming property in the Victorian Mallee. The forage shrub saltbush is an important part of the feed base of this sheep-cropping property. While the property is predominately reliant on cropping, 42% of the 4658 ha business is allocated to pasture production. Of this area 72% is either native saltbush or planted saltbush. Saltbush has allowed the farmer to make productive use of land unsuitable for cropping, and importantly fills feed gaps of the annual pasture system during late spring and autumn (Figures 1 and 2). With a high proportion of forage shrubs making up the pasture mix the expanded Feed Demand Calculator is an ideal planning support tool for this business. This farmer has been able to identify benefits in the future of improved grazing efficiency and better forage

utilisation of the saltbush, with underutilised forage resource available during the spring and autumn (Figure 2).
A second case study developed for a mixed-farming property in the Victorian Mallee presented an opportunity for the producer to evaluate the feed supply and demand throughout a 12 month period based on their current sheep breeding enterprise. Saltbush makes up 29% of the 530 ha pasture area on this property. As this business is considering the addition of a livestock trading enterprise the expanded FDC will allow this producer to explore the effect of this change on pasture supply and demand. The soils on this property are prone to soil erosion at times, as such the identification of potential gaps in the feed base will be an important part of managing any additional livestock enterprise.

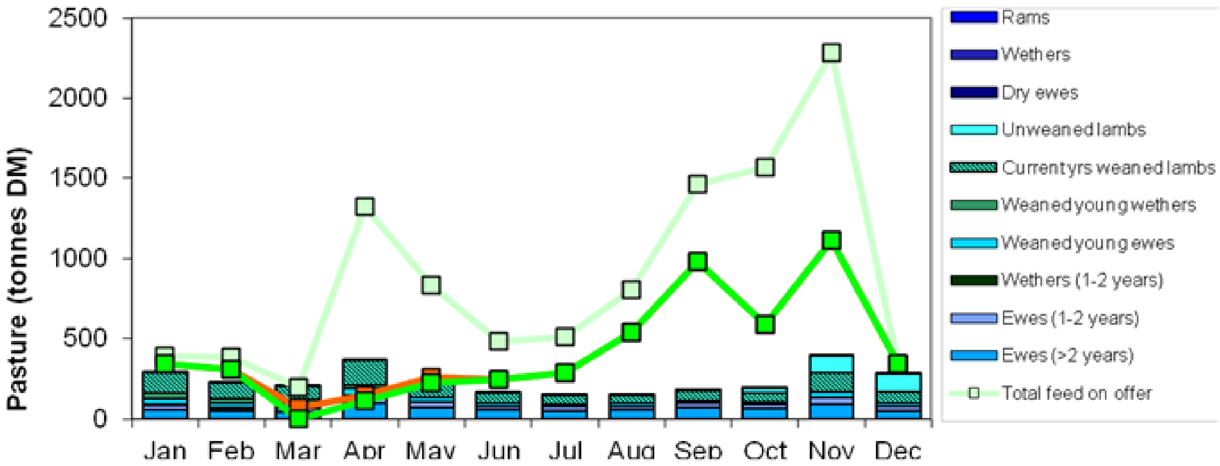

Figure 1. Feed demand of livestock overlaid by both fresh and total pasture feed on offer over a 12 month period, highlighting peak livestock feed demand and feed supply.

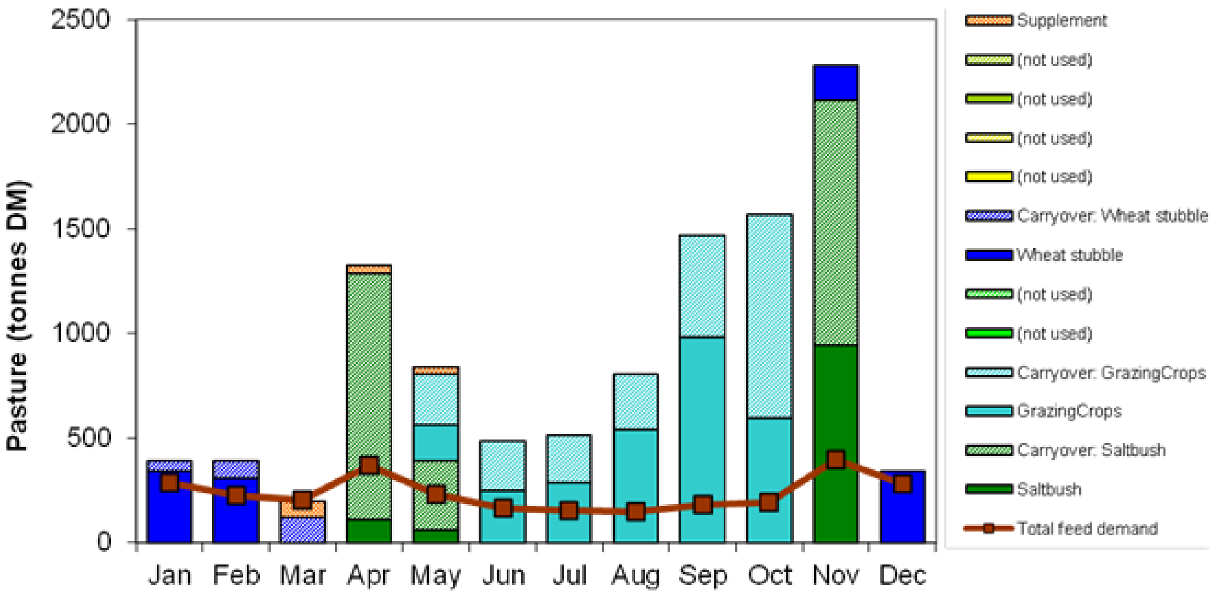

Figure 2. Total pasture on offer demonstrating the key feed sources at different times over a 12 month period, overlaid by total livestock feed demand. Included is the supplementary feed supply of hay and grain.

The FDC was designed as an interactive learning tool to allow producers a means of understanding their livestock feed and demand, and the relative forage supply (Moore and Freer 2005) over the long term. As such, there are limitations of the FDC: it is based on long term averages but does not take into account variability. This is particularly relevant in the low rainfall zone where there are extreme variations in within year and the intra-year variability. There would be value to producers and advisors in presenting the calculator outputs across a range of rainfall deciles, allowing seasonal variation in pasture production to be explored. Additionally, the modelling is not sensitive to soil conditions such as salinity, high water tables or toxicities of chemicals within the root zone that may affect plant growth. However, it is important to view the FDC along a continuum of tools for the analysis of mixed farming systems (Bell et al. 2008), where it sits as a relatively simple tool intended to encourage common use.

Conclusion

The addition of the forage shrub species saltbush to the existing whole farm feed decision support tool, the expanded Feed Demand Calculator, will enable farmers and advisors to plan and make more informed management decision about their pasture feed base. In addition to forage shrubs, the inclusion of additional locations in the low rainfall environment has taken an existing tool and increased the applicability across a wider range of environments. Forage shrubs can occupy a small but valuable role on a mixed farm and this tool is intended to encourage greater evaluation and identification of their role in specific whole-farm contexts.

Acknowledgements

This work was undertaken as part of the GRDC-funded CRC Future Farm Industries EverCrop project, a collaboration between DAFWA, CSIRO, NSWDPI, SARDI and regional partners including Mallee Sustainable Farming who partnered in this project.

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