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StockPlan—Exploring Management Options before Dry Spells and in Drought: 1. Development and Description

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ABSTRACT StockPlan is an accredited workshop that assists cattle, sheep meat, and wool producers improve drought management decisions and develop drought plans during dry spells and drought. The objectives of this article are to (1) describe the development of the StockPlan workshop; and (2) describe the equations used in the StockPlan decision support tools (DST). The StockPlan workshop provides training to producers in how to use four DST: (1) Drought Pack based on metabolizable energy (ME) requirements for maintenance and weight gain, calculates the break-even price for different classes of sheep and cattle [e.g., weaners (not suckling), dry, lactating or pregnant stock] for a specified planning period (1–12 months); (2) Feed Sell Agist (FSA) Pack provides an economic analysis of the decision to either: keep and feed, sell, or agist (i.e., moving stock to leased pasture) livestock across different time periods with an option to enter the probability of a drought occurring. FSA Pack calculates an expected value for feed, sell, or agist options across economic variables: costs, cash flow, and bottom line; (3) ImPack assesses the future structure of a herd or flock during a 5- or 10-year planning period; and (4) PlanPack is an interactive word document designed to help producers develop a drought plan. The equations behind the DST Drought Pack, FSA Pack, and ImPack are reported.The StockPlan workshop provides producers with the information and confidence to assist in making better decisions when faced with a prolonged dry spell or impending drought.

Impact Statement Understanding the financial consequences of management options before dry spells and in drought are important issues for producers (i.e., ranchers). The StockPlan workshop provides training in the use of Drought Pack, FSA Pack, and ImPack. Development of the workshop and a description of the equations are provided. Fostering drought preparedness is critical.

Dry spells and drought frequently occur not only in Australia but throughout the world. A dry spell arises when a below-average rainfall and consequently a low pasture growth rate (kg ha^{-1} d^{-1}) has occurred, which can lead to either a winter or seasonal drought (Fig. 1). On-farm management decisions affect the environment and a producer's financial position. Therefore, pro-active steps that involve auditing, setting objectives and strategies, monitoring performance, reviewing the whole-farm enterprise, and making future predictions of productivity have the potential to reduce the environmental and financial impacts of dry spells and droughts (Fig. 1).

The StockPlan workshop assists cattle, sheep meat, and wool producers take pro-active steps to improve drought management decisions and develop drought plans. The StockPlan workshop provides training in the use of four decision support tools (DST): Drought Pack, Feed Sell Agist (FSA) Pack, ImPack, and PlanPack. A brief overview of the StockPlan software and workshop has previously been reported by McPhee et al. (2007, 2010).

A number of DST, for example, DroughtPlan (Stafford Smith, 1995; DroughtPlan, 2000), Grazfeed (Freer et al., 1997; GrazFeed, 1998), and RANGEPACK (Stafford Smith and Foran, 1990) are available to assist managers make decisions during drought. However, the four StockPlan DST are unique because of the emphasis on an economic output. The StockPlan workshop provides producers with a forum to discuss and evaluate management decisions. The objectives of this article are to (1) describe the development of the StockPlan workshop, and (2) describe the equations in the StockPlan DST.

MATERIALS AND METHODS

Development of StockPlan

Identification of the Need

A need to upgrade or develop a new DST to assist Australian producers during drought was first identified in 1999 when a team from NSW Department of Primary Industries took the initiative to develop a drought website. The first DST identified was Drought Pack (Whelan, 1982), which was originally written for an Apple IIe computer and subsequently converted to an IBM DOS program.

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Abbreviations: DST, decision support tools; ME, metabolizable energy.

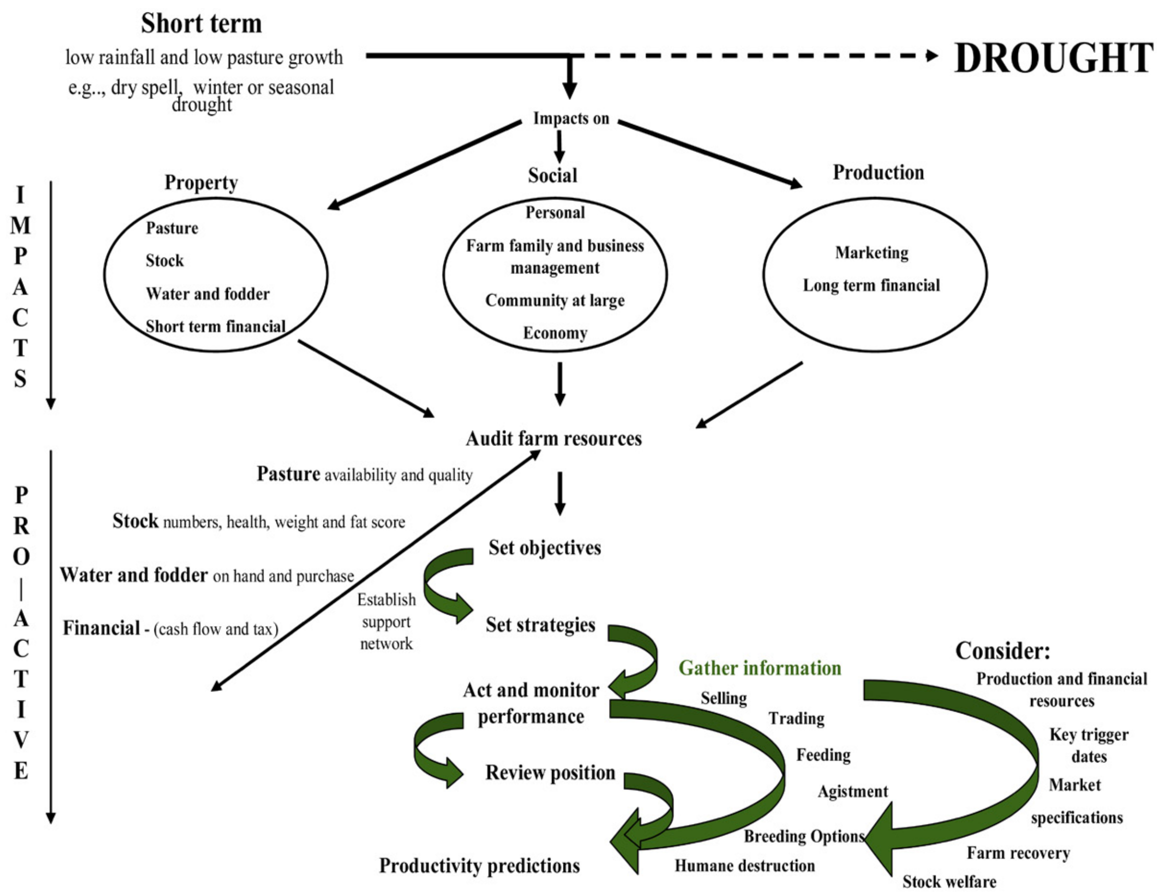

Fig. 1. Potential impacts on property, social life, and production when a below average rainfall and subsequent low pasture growth has occurred; pro-active steps are outlined, for example, selling, trading, supplementary feeding, agistment, breeding options, and humane destruction.

During the 1999 drought DroughtPlan (Stafford Smith, 1995), a CD-ROM containing a number of decision tools that focus on managing climate variability, and GrazFeed (Freer et al., 1997; GrazFeed, 1998), an animal and pasture simulation model that predicts feed intake (kg DM d^{-1}) (DM, dry matter) of grazing animals (cattle and sheep) and their energy and protein requirements during a 24-hour period were evaluated. Despite recognizing these as valuable tools for undertaking specific tasks relating to drought, it was decided that Drought Pack was significantly different, particularly in relation to assessing feeding strategies across several months, warranting its further development. The decision was based on the ability of Drought Pack to assess the cash flow of a farm when drought feeding and calculate a break-even price for specific animal classes across a specified planning period (e.g., January–March). Climate variability was also discussed and was considered an important topic that needed to be addressed within the proposed producer workshops.

Six significant tasks that would progress the development of StockPlan were identified: (1) upgrade Drought Pack to Microsoft Windows environment; (2) develop two additional DST: FSA Pack to provide an economic analysis to either feed, sell, or agist (i.e., moving stock to leased pasture at a specified cost on a weekly, monthly, or annual basis) stock; and ImPack that would allow users to evaluate breeding, selling, and buying strategies for any cattle breeding herd or sheep flock; (3) include a session on climate variability using Rainman (Clewett et al., 1999) to educate producers on how climate variability impacts the annual rainfall and pasture growth by illustrating weather patterns specific to the location where the StockPlan workshop would be conducted; (4) form a StockPlan steering committee comprising livestock and agronomy officers, an economist, a livestock production modeler, and technical specialists in the areas of grazing management and climatology; (5) hold a pilot workshop using a prototype version with a group of producers; and (6) develop a team of accredited workshop leaders.

After the significant tasks were completed, a need existed to assist producers develop a drought plan. Therefore, a paper-based DST called PlanPack was developed to assist producers to systematically work through issues related to either dry spells or drought.

Feasibility Analysis

In 2001 two pilot workshops (with eight producers at each) were held to evaluate Drought Pack. At the pilot workshops the conceptual ideas of StockPlan and a description of the conceptual ideas of FSA Pack and ImPack were presented. The first workshop was held in a winter rainfall environment (Orange, NSW) where producers face dry spells during summer and autumn. The second workshop was held in a summer rainfall environment (Armidale, NSW), where producers face feed shortages during late autumn and early winter.

Method and Delivery of StockPlan

Feedback from the pilot workshops indicated that producers would require a "hands-on" approach to learning how to use the DST. The purpose of the StockPlan workshops would seek to encourage producers to learn in an interactive environment with group discussions and interpretation of results. All StockPlan workshops were to include sessions on climate variability, techniques for accessing information from the Internet, and a segment on tactical and strategic decision making during dry spells addressing the possibility of severe drought, and demonstrations of the StockPlan DST. The workshop has been accredited by NSW Department of Primary Industries as a PROfarm course. Livestock advisers or private consultants were to conduct the workshop after they had completed a "train the trainer" course.

StockPlan

StockPlan is a suite of activities that train producers in exploring management options during dry spells and in drought. The activities can be undertaken during workshops and subsequently at home. Participants of a StockPlan workshop receive five items: (1) a Producer Manual (NSW Department of Primary Industries, 2005) that includes activities to assist producers draw on their own experiences and assess risk factors; (2) a Home Study Guide that outlines a 5-step planning process; (3) a CD containing the StockPlan DST; (4) a CD containing the StockPlan resource manual—helpful information on decision making, risks associated with droughts, drought management, property planning and management, computer tools and scenarios, case studies (NSW Department of Primary Industries, 2005); and (5) a drought management booklet (NSW Department of Primary Industries, 2006). The integration of the four separate DST (Table 1) is an integral component of the StockPlan workshop. They were developed because no single DST could address all the complexities of pro-active decision making (Fig. 1) required before the onset of dry spells or during drought. Depending on a producer's circumstances they may choose 1 or more of the components of the StockPlan DST or resources.

The aim of StockPlan is to help producers make management decisions that minimize the environmental and financial impacts of drought. Interaction between the participants is an important element of the workshop. Management options are explored through StockPlan DST and StockPlan resources that cover a wide variety of topics (e.g., decision making process, drought and over grazing issues, animal health and welfare, climate, a producer's personal story about drought, and "where to get help").

StockPlan is a useful tool for evaluating the following questions:

- How much will it cost to drought feed my stock for a specified time?
- How will my decision affect my herd or flock and financial position?
- Will my long-term financial situation stabilize or improve if I keep and feed stock, sell stock, or agist my stock?
- Is agistment an option for certain classes of animals?

Drought Pack

Drought Pack is based on metabolizable energy (ME) requirements for maintenance and weight gain (MAFF 1975; Oddy 1978; AFRC 1993). It calculates the cost of drought feeding and the break-even price for animal (sheep and cattle) classes [e.g., weaners (stock not suckling), dry, lactating, or pregnant stock] for a specified planning period (1–12 months). Abbreviations and units are described in Table 2. To calculate the associated drought feeding costs and break-even price for animal classes, the following Eq. [1] to [13] (MAFF, 1975) are used. The sheep (SheepMainReq) and cattle (CattleMainReq) maintenance requirements (MJ $kg^{-0.75}$ d^{-1}) are calculated as follows:

$$\mathrm{SheepMainReq} = 0.25 \times \mathrm{LW}^{0.75} \times \mathrm{SPAC} \qquad [1]$$

Table 1. The main purpose and key elements of the four StockPlan decision support tools (DST) for cattle, sheep meat, and wool producers.

DST	Main purpose	Key elements
Drought Pack	Financial consequences of management and feeding strategies.	• Monthly planning period. • Calculates nutritional requirements. • Energy based model. • Estimates break-even prices for classes of stock.
Feed Sell Agist (FSA) Pack	Economic analysis of the decision to either feed, sell, or agist.	• Can specify up to four different drought lengths. • Provides "cash cost" and "bottom line" estimates. • Re-establishment costs can be entered. • Expected costs are based on the probability of an event occurring. • Provides the opportunity to analyze the sensitivity of results.
ImPack	Explores the consequences of a drought-forced reduction (i.e., feeding and restocking) through analyzing the breeding, selling, and buying strategies to re-build stock numbers to pre-drought levels.	• Analysis of the herd/flock age structure, animal production, and cash flow. • Results provided on an annual basis over a 6- or 11-year period. • Comparative analysis between original herd or flock and alternative methods of recovery. • Comparative analysis of management options.
PlanPack	Develops a drought plan.	• Progressively steps through the development of a drought plan.

Table 2. Description of terms used for calculating the amount of feed required in DroughtPack.

Item	Description	Units
CattleGainReq	The amount of net energy available for gain	MJ d^{-1}
CattleMainReq	Fasting metabolism per unit of metabolic weight (i.e., fasting heat production)	MJ $kg^{-0.75}$ d^{-1}
CPAC	Cattle physiology within animal class	*n*
DMmaint	Dry matter maintenance; amount of DM feed for maintenance	g DM d^{-1} for sheep kg DM d^{-1} for cattle
DMPer	Dry matter percentage of feed	%
DMreq	Dry matter requirement; amount of DM feed for gain	g DM d^{-1} for sheep kg DM d^{-1} for cattle
EffOfConv	Efficiency of use of ME for gain	*n*
LW	Liveweight	kg
LWG	Liveweight gain	g d^{-1} for sheep kg d^{-1} for cattle
MainEff	Maintenance efficiency	MJ d^{-1}
M/D	ME concentration of the feed	MJ ME kg^{-1} DM
MEgain	ME gain adjusted for the efficiency of use	MJ d^{-1}
SheepGainReq	The amount of net energy available for gain	MJ d^{-1}
SheepMainReq	Fasting metabolism per unit of metabolic weight (i.e., fasting heat production)	MJ $kg^{-0.75}$ day^{-1}
SheepMEgain	ME intake necessary for gain	MJ d^{-1}
SPAC	Sheep physiology within animal class	*n*
Total As-fed	As-fed basis	g DM d^{-1} for sheep kg DM d^{-1} for cattle
TotalDMReq	Total DM feed required	g DM d^{-1} for sheep kg DM d^{-1} for cattle

$$\text{CattleMainReq} = 0.35 \times \text{LW}^{0.75} \times \text{CPAC} \quad [2]$$

where LW (kg) is live weight for sheep or cattle; CPAC is cattle physiology within animal class, SPAC is sheep physiology within animal class (Table 2); and parameter values 0.25 and 0.35 represent fasting metabolism (MJ $kg^{-0.75}$ d^{-1}) for sheep and cattle, respectively. The physiology values (SPAC and CPAC) for each animal class are reported in Table 3.

If liveweight gain (LWG; g d^{-1} for sheep and kg d^{-1} for cattle) > 0, then the amount of energy stored as gain for sheep (SheepGainReq) and cattle (CattleGainReq) (MJ d^{-1}) are calculated as follows:

$$\text{SheepGainReq} = 10^{[1.11 \times \log(\text{LWG}) + 0.004 \times \text{LW} - 2.12]} \quad [3]$$

$$\text{CattleGainReq} = \frac{(6.28 + 0.0188 \times \text{LW}) \times \text{LWG}}{(1 - 0.3 \times \text{LWG})} \quad [4]$$

If LWG ≤ 0, then ME required for sheep and cattle (MJ d^{-1}) are calculated as follows:

$$\text{SheepGainReq} = 40 \times \frac{\text{LWG}}{1000} \times 0.90 \quad [5]$$

$$\text{CattleGainReq} = 40 \times \text{LWG} \times 0.90 \quad [6]$$

where 0.90 is a loss efficiency within all animal classes for sheep and cattle, respectively. The maintenance efficiency (MaintEff; MJ d^{-1}) and the efficiency of use of ME for gain (EffOfConv) are calculated as follows:

$$\text{MaintEff} = 0.55 + 0.016 \times \frac{M}{D} \quad [7]$$

$$\text{EffOfConv} = 0.0435 \times \frac{M}{D} \quad [8]$$

where *M/D* is designated as a term used to describe the ME concentration of the feed ration (MJ ME g^{-1} DM for sheep and MJ ME kg^{-1} DM for cattle; nutrient requirements of domesticated ruminants (Freer et al., 2007); this does not assume that all feeds have an equivalent feed conversion rate if they have equal energy concentrations; *M* and *D* are not variable names and hence no division occurs). The ME gain (MJ d^{-1}) adjusted for efficiency of use of ME for gain (MEgain) is as follows:

$$\text{MEgain} = \frac{(\text{SheepGainReq}) \text{ or } (\text{CattleGainReq})}{\text{EffOfConv}} \quad [9]$$

The amount of DM feed required (DMreq) for gain and maintenance (DMmaint) (g d^{-1} for sheep and kg d^{-1} for cattle) are calculated as follows:

$$\text{DMreq} = \frac{\text{MEGain}}{\frac{M}{D}} \quad [10]$$

$$\text{DMmaint} = \frac{\frac{(\text{SheepMainReq}) \text{ or } (\text{CattleMainReq}) \times 1.1}{\text{MainEff}}}{\frac{M}{D}} \quad [11]$$

The total values for DM requirement (TotalDMReq) and as-fed (TotalAsFed) (g d^{-1} for sheep and kg d^{-1} for cattle) are calculated as follows:

Table 3. Values for sheep physiology within animal class (SPAC) and cattle physiology within animal class (CPAC) used in DroughtPack.

SPAC		CPAC	
Animal class	Value	Animal class	Value
Dry ewe	1.00	Dry cow	1.00
Pregnant ewe	1.33	Pregnant cow	1.30
Early lactating ewe	2.50	Early lactating cow	1.75
Late lactating ewe	1.60	Late lactating cow	1.63
Weaned† lamb	1.00	Weaned[1] calf	1.00
Hogget	1.00	Young cattle	1.00
Wether	1.00	Steer	1.00
Ram	1.00	Bull	1.00

† Stock not suckling.

$$\text{TotalDMReq} = \text{DMreq} + \text{DMmaint} \quad [12]$$

$$\text{TotalAsFed} = \frac{\text{TotalDMReq} \times 100}{\text{DMPer}} \quad [13]$$

where DMPer is dry matter percentage of feed. The financial impact of drought feeding can be viewed either as a feed summary, cash flow, or break-even price report. The feed summary reports the number of stock, the total amount fed, and cost of feed across each month in the planning period; the cash flow report includes an opening and closing livestock valuation that highlights the changes in livestock values costs and income and a running balance across each month in the planning period; and the break-even price reports the initial value of the stock at the beginning of the planning period, interest foregone on sale, cost of feeding, interest on feeding, associated costs, and a break-even calculation that assists the user to determine whether or not to retain stock.

FSA Pack

FSA Pack provides an economic analysis of the decision to either keep and feed, sell, or agist stock. It is designed to evaluate the cost of various options for a specific class of livestock rather than a whole herd or flock. Four time periods are defined (short, medium, long, and worst case) to evaluate the consequences of a dry spell developing into a prolonged drought (i.e., up to 80 weeks). Inputs include duration of the drought, feed costs, stock value and the expected purchase price at the end of each time period, income from progeny or wool sale or from both, value of feed in paddock and re-establishment costs, the cost savings associated with normal management practices [e.g., on a sheep enterprise cost savings for not jetting (useful tool for chemical applications) and crutching throughout a long drought period (between 8 and 32 weeks)] and the probability of a drought occurring within a short, medium, long, or worst case scenario.

FSA Pack calculates the financial impact of feed costs (feed or agistment, labor, and interest paid on borrowings), cash flow (income – feed costs), change in stock value (estimated value of stock at the start of the drought compared with the anticipated value at the end), and bottom line (accurate assessment of the long-term impact of feeding, selling, or agisting) assessment. If the option to enter probabilities for each of the drought time periods is selected then the weighted mean (i.e., the expected value) is calculated according to the probabilities that were entered for each of the drought time periods as follows:

$$\text{ExpectedValue}_{ij} = \sum_{k=1}^{4} p_k \times \text{Value}_{ijk} \quad [14]$$

where $\text{ExpectedValue}_{ij}$ is the expected dollar value ($) for each management option i = 1 to 3: sell, feed, or agist, respectively and financial impact j = 1 to 3: costs, cash flow, or bottom line, respectively; p the probability that the user entered for the drought time periods k =1 to 4: short, medium, long, and worst case, respectively; and Value_{ijk} is the dollar value ($) of the management options (i = 1 to 3), financial impact (j = 1 to 3) at the drought time periods (k = 1 to 4), which are calculated after all data have been entered for the management option and the financial impact for each time period.

ImPack

ImPack provides the user with the opportunity to assess the future structure of the herd or flock during a 5- or 10-year planning period. The development of the herd and flock equations are based on the age and herd distribution equations of Dobos et al. (1997). Minor modifications have been made to the herd equations and the framework of the herd equations was used to develop the flock equations. Abbreviations and units of cow breeding rate and age distribution are described in Table 4 and the ewe breeding and wether flock rate and age distribution are described in Table 5.

The cow breeding rate and age distribution of a herd are calculated in Eq. [15] to [33]. The cow calving rate (CCR) is calculated as follows:

$$\text{CCR} = \frac{\text{CW}}{100} + \frac{6}{12} \times \frac{\text{CW}}{100} \times \frac{\text{CWD}}{100} + \frac{\text{CAC}}{100} \quad [15]$$

where CW is the cow weaning (stock not suckling) percentage (%); 6/12 represents a 6-month period between birth and weaning; CWD is the cow weaning death percentage (%); and CAC is the cow adult cull percentage (%). The cow gestation rate (CGR) and pregnancy rate (CPR) are calculated as follows:

$$\text{CGR} = \text{CCR} \times \frac{\text{CAD}}{100} \times \frac{282}{365} \quad [16]$$

$$\text{CPR} = \text{CCR} + \text{CGR} + \text{CGR} \times \frac{\text{CAD}}{100} \times \frac{282}{365} \quad [17]$$

where CCR is calculated using Eq. [15]; CAD the cow adult death percentage (%); and 282/365 represents the 282 days of gestation for cows. The cow breeding rate (CBR_i) for i = 2 to maximum age at joining (MaxAJ) are calculated as follows:

$$\text{CBR}_i = \text{CBR}_{i-1} \times \left[1 - \frac{\text{CAD}}{100} - \frac{\text{CAC}}{100} - (1 - \text{CPR}) \times \frac{\text{CFRC}}{100}\right] \quad [18]$$

where CBR_1 = 1 and CAD and CAC are described in Table 4, and CFRC is cow failed to rear percent (%). The number of cows distributed across ages (CAgeDist_i) for i = 1 to MaxAJ is calculated as follows:

Table 4. Description of terms used for calculating the cow breeding rate and age distribution in ImPack.

Item	Description	Units
AdultCowsSold	Adult cows sold	*n*
CAC	Cow adult culls	%
CAD	Cow adult death	%
CAgeDist	Number of cows distributed across ages	*n*
CalvesReq	Calves required	*n*
CalvesWeaned	Calves weaned†	*n*
CBR	Cow breeding rate	*n*
CCR	Cow calving rate	*n*
CCulls	Cow culls	*n*
CDeaths	Number of cow deaths	*n*
CGR	Cow gestation rate	*n*
CowDrysSold	Number of dry cows sold	*n*
CPR	Cow pregnancy rate	*n*
CFRC	Cow failed to rear a calf	%
CW	Cow weaning	%
CWD	Cow weaning death	%
HerdPer	Herd percentage	%
MaxAJ	Maximum age at joining	years
TCM	Total number of cows mated	*n*
TotDryCows	Total number of dry cows	*n*
TotDryCowsSold	Total number of dry cows sold	*n*

† Stock not suckling.

$$\text{CAgeDist}_i = \text{round}\left[\frac{\text{CBR}_i}{\sum_{i=1}^{\text{MaxAJ}} \text{CBR}_i} \times \text{TCM}\right] \quad [19]$$

where CBR_i is described above in Eq. [18] and TCM is the total number of cows mated. The number of cows distributed at the start of year 1 (i.e., $i = 0$) is calculated as follows:

$$\text{CAgeDist}_0 = \frac{\text{CAgeDist}_1}{1 - \frac{\text{CWD}}{100} \times \frac{1}{2}} \quad [20]$$

which is based on the calculation of CAgeDist_1, the cow age distribution in Year 1 (Eq. [19]), CWD is described in Table 4, and 1/2 is a 50% reduction in the CWD to determine the number of cows at the start of the year. The cow culls (CCulls_i) for i = 1 to MaxAJ are calculated as follows:

$$\text{CCulls}_i = \text{CAgeDist}_i \times \frac{\text{CAC}}{100} \quad [21]$$

which is based on the calculation of CAgeDist_i for i = 1 to MaxAJ (Eq. [19]) and CAC is described in Table 4. The number of cow deaths (CDeaths_i) across ages for i = 1 to MaxAJ are calculated as follows:

$$\text{CDeaths}_i = \text{CAgeDist}_i \times \frac{\text{CAD}}{100} \quad [22]$$

which is based on the calculation of CAgeDist_i for i = 1 to MaxAJ (Eq. [19]) and CAD is described in Table 4. The number of calves required (CalvesReq) is calculated as follows:

Table 5. Description of terms used for calculating the ewe and wether breeding rate and age distribution in ImPack.

Item	Description	Units
AdultEwesSold	Adult ewes sold	*n*
EAC	Ewe adult culls	%
EAD	Ewe adult death	%
EAgeDist	Number of ewes distributed across ages	*n*
EBR	Ewe breeding rate	*n*
ECulls	Ewe culls	*n*
EDeaths	Number of ewe deaths	*n*
EFRL	Ewe failed to rear a lamb	%
EGR	Ewe gestation rate	*n*
ELR	Ewe lambing rate	*n*
EPR	Ewe pregnancy rate	*n*
EW	Ewe lamb weaning	%
EWD	Ewe lamb weaning death	%
EweDrysSold	Number of dry ewes sold	*n*
LambReq	Lambs required	*n*
LambsWeaned	Lambs weaned†	*n*
MaxAJ	Maximum age at joining	years
MaxSA	Maximum shearing ages	years
ReplacementWReq	Number of replacement wethers required	*n*
TEJ	Total number of ewes joined	*n*
TotEwesForSale	Total number of ewes for sale	*n*
WAC	Wether adult cull	%
TW	Total number of wethers in the flock	*n*
WAD	Wether adult death	%
WAgeDist	Number of wethers distribution across ages	*n*
WBR	Wether breeding rate	*n*
WCullForAgeSold	Number of wethers culled for age sold	*n*
WOtherCullsSold	Number of other culls sold	*n*

† Stock not suckling.

$$\text{CalvesReq} = \text{round}\left[\frac{\text{CAgeDist}_0}{1 - \frac{\text{CWD}}{100} \times \frac{1}{2}}\right] \quad [23]$$

which is based on the calculation of CAgeDist_0, the cow age distribution at the start of year 1 (Eq. [20]) and CWD is described in Table 4. The number of calves weaned (CalvesWeaned) is calculated as follows:

$$\text{CalvesWeaned} = \text{CalvesReq} - \text{CAgeDist}_1 \quad [24]$$

where ClavesReq is calculated using Eq. [23] and CAgeDist_1 is calculated using Eq. [19]. The herd percentage (HerdPer_i, %) for i = 1 to MaxAJ is calculated as follows:

$$\text{HerdPer}_i = \frac{\text{CAgeDist}_i}{\text{TCM}} \times 100 \quad [25]$$

where CAgeDist_i is calculated using Eq. [19] and TCM is described in Table 4. The total number of dry cows (TotDryCows) and the total number of dry cows sold (TotDryCowsSold) are calculated as follows:

$$\text{TotDryCows} = (1 - \text{CPR}) \times \text{TCM} \quad [26]$$

$$\text{TotDryCowsSold} = (1 - \text{CPR}) \times \text{TCM} \times \frac{\text{CFRC}}{100} \quad [27]$$

where CPR, TCM, and CFRC are described in Table 4. The number of dry cows sold across ages ($CowDrysSold_i$) where i = 1 to MaxAJ are calculated as follows:

$$\text{CowDrysSold}_i = \text{round}\left[\text{TotDryCowsSold} \times \text{HerdPer}_i\right] \quad [28]$$

where TotDryCowsSold is calculated using Eq. [27] and $HerdPer_i$ is calculated using Eq. [25]. The number of adult cows sold (AdultCowsSold) is calculated as follows:

$$\text{AdultCowsSold} = \text{round}\left[\text{CAgeDist}_{\text{MaxAJ}} \times \left[1 - \left(\frac{\text{CAD}}{100}\right) - \left(\frac{\text{CAC}}{100}\right) - (1-\text{CPR}) \times \left(\frac{\text{CFRC}}{100}\right)\right]\right] \quad [29]$$

where $CAgeDist_{MaxAJ}$ is calculated using Eq. [19]; CPR is calculated using Eq. [17]; and CAD, CAC, and CFRC are described in Table 4. If heifers are sold at 1 year of age the number of heifers sold (HeifersSold) is calculated as follows:

$$\text{HeifersSold} = \text{round}\left[\left[\left(\frac{1}{2} \times \frac{\text{CW}}{100}\right) \times \text{TCM} \times \left(1 - \frac{\text{CWD}}{100}\right) - \text{CAgeDist}_1\right] \times \left(1 - \frac{\text{CAD}}{100}\right)\right] \quad [30]$$

If heifers are sold at 2 years of age then the number of heifers sold is calculated as follows:

$$\text{HeifersSold} = \text{round}\left[\left(\frac{1}{2} \times \frac{\text{CW}}{100}\right) \times \text{TCM} \times \left(1 - \frac{\text{CWD}}{100}\right) - \text{CAgeDist}_1\right] \quad [31]$$

where CW, TCM, CWD, and CAD are described in Table 4, and $CAgeDist_1$ is calculated using Eq. [19]. If steers are sold at 1 year of age the number of steers sold (SteersSold) is calculated as follows:

$$\text{SteersSold} = \text{round}\left[\left[\left(\frac{1}{2} \times \frac{\text{CW}}{100}\right) \times \text{TCM} \times \left(1 - \frac{\text{CWD}}{100}\right)\right] \times \left(1 - \frac{\text{CAD}}{100}\right)\right] \quad [32]$$

If steers are sold at 2 years of age then the number of steers sold is calculated as follows:

$$\text{SteersSold} = \text{round}\left[\left(\frac{1}{2} \times \frac{\text{CW}}{100}\right) \times \text{TCM} \times \left(1 - \frac{\text{CWD}}{100}\right)\right] \quad [33]$$

where CW, TCM, CWD, and CAD are described in Table 4.

The ewe breeding rate and age distribution of a flock are calculated in Eq. [34] to [50]. The ewe lambing rate (ELR) is calculated as follows:

$$\text{ELR} = \frac{\text{EW}}{100} + \frac{15}{52} \times \frac{\text{EW}}{100} \times \frac{\text{EWD}}{100} + \frac{\text{EAC}}{100} \quad [34]$$

where EW is the ewe lambing percentage (%); 15/52 represents the 15 weeks between birth and weaning; EWD is the ewe lamb weaning death percentage (%); and EAC is the ewe adult cull percentage (%). The ewe gestation rate (EGR) is calculated as follows:

$$\text{EGR} = \text{ELR} \times \frac{\text{EAD}}{100} \times \frac{150}{365} \quad [35]$$

where EAD is the ewe adult death percentage (%); and 150/365 represents the ewe gestation period of 150 days. If the flock is self-replacing, then the ewe pregnancy rate (EPR) is calculated as follows:

$$\text{EPR} = 0.95 \times \left[\text{ELR} + \text{EGR} + \text{EGR} \times \frac{\text{EAD}}{100} \times \frac{150}{365}\right] \quad [36]$$

Or if the flock is not self-replacing, then the ewe pregnancy rate is calculated as follows:

$$\text{EPR} = 0.85 \times \left[\text{ELR} + \text{EGR} + \text{EGR} \times \frac{\text{EAD}}{100} \times \frac{150}{365}\right] \quad [37]$$

where ELR is calculated using Eq. [34], EGR is calculated using Eq. [35], and EAD is described above (Table 5).

The ewe breeding rates across ages (EBR_i) for i = 2 to MaxAJ are calculated as follows:

$$\text{EBR}_i = \text{EBR}_{i-1} \times \left[1 - \frac{\text{EAD}}{100} - \frac{\text{EAC}}{100} - (1-\text{EPR}) \times \frac{\text{EFRL}}{100}\right] \quad [38]$$

where EBR_1 = 1 and EAD and EAC are described above (Table 5), EPR is defined using Eq. [36] or Eq. [37], and EFRL is the ewe failed to rear a lamb percentage (%). The ewes distributed across ages ($EAgeDist_i$) for i = 1 to MaxAJ are calculated as follows:

$$\text{EAgeDist}_i = \frac{\text{EBR}_i}{\sum_{i=1}^{\text{MaxAJ}} \text{EBR}_i} \times \text{TEJ} \quad [39]$$

where EBR_i is described above in Eq. [38] and TEJ is the total number of ewes joined. The number of ewes distributed at the start of year 1 (i.e., i = 0) is calculated as follows:

$$\text{EAgeDist}_0 = \frac{\text{EAgeDist}_1}{1 - \frac{\text{EAD}}{100} \times \frac{1}{2}} \quad [40]$$

where EAD is described above (Table 5) and 1/2 is a 50% reduction in the EAD to determine the number of ewes at the start of the year. The number of ewe culls ($ECulls_i$) and deaths ($EDeaths_i$) across ages for i = 1 to MaxAJ are calculated as follows:

$$\text{ECulls}_i = \text{EAgeDist}_i \times \frac{\text{EAC}}{100} \quad [41]$$

$$\text{EDeaths}_i = \text{EAgeDist}_i \times \frac{\text{EAD}}{100} \quad [42]$$

where $EAgeDist_i$ is calculated using Eq. [39] and EAC and EAD are described above (Table 5).

The number of lambs required (LambsReq) is calculated as follows:

$$\text{LambsReq} = \frac{\text{EAgeDist}_0}{1 - \frac{\text{EWD}}{100} \times \frac{1}{2}} \quad [43]$$

where $EAgeDist_0$ is calculated using Eq. [40] and EWD is described above (Table 5). The number of lambs weaned (LambsWeaned) is calculated as follows:

$$\text{LambsWeaned} = \text{LambsReq} - \text{EAgeDist}_1 \quad [44]$$

where LambsReq is calculated using Eq. [43] and $EAgeDist_1$ is calculated using Eq. [39]. The ewe percentage ($EwePer_i$, %) for i = 1 to MaxAJ is calculated as follows:

$$\text{EwePer}_i = \frac{\text{EAgeDist}_i}{\text{TEJ}} \times 100 \quad [45]$$

where $EAgeDist_i$ is calculated using Eq. [39] and TEJ is described in Table 5.

The number of wethers (Wethers) is calculated as follows:

$$\text{Wethers} = \frac{1}{2} \times \frac{\text{EW}}{100} \times \text{TEJ} \times (1 - \frac{\text{EWD}}{100}) \quad [46]$$

where EW, TEJ, and EWD are described above (Table 5). For a self-replacing flock the number of maidens (Maidens) is calculated as follows:

$$\text{Maidens} = \text{Wethers} - \text{EAgeDist}_0 \quad [47]$$

where the number of Wethers is calculated in Eq. [46] and $EAgeDist_0$ calculated in Eq. [40]. The number of cull for age ewes (CullForAgeEwes) is calculated as follows:

$$\text{CullForAgeEwes} = \text{round}\left[\text{EAgeDist}_{\text{MaxAJ}} \times \left[1 - \left(\frac{\text{EAD}}{100}\right) - \left(\frac{\text{EAC}}{100}\right) - (1 - \text{EPR}) \times \left(\frac{\text{EFRL}}{100}\right)\right]\right] \quad [48]$$

where $EAgeDist_{MaxAJ}$ is calculated using Eq. [39], EPR is calculated using either Eq. [36] or [37], and EAD, EAC, and EFRL are described in Table 5. The total number of cull ewes (TotCullEwes) for sale is calculated as follows:

$$\text{TotCullEwes} = \frac{\text{EAC}}{100} \times \text{TEJ} \quad [49]$$

where EAC and TEJ are described in Table 5. The total number of dry ewes (TotalDryEwes) is calculated as follows:

$$\text{TotalDryEwes} = \text{TEJ} \times (1 - \text{EPR}) \times \frac{\text{EFRL}}{100} \quad [50]$$

where EPR is calculated using Eq. [36] or [37] and TEJ and EFRL are described in Table 5. The wether flock rate and age distribution of a wether flock are calculated in Eq. [51] to [57]. The wether flock rate (WFR_i) across ages for i = 2 to maximum shearing age (MaxSA) is calculated as follows:

$$\text{WFR}_i = \text{WFR}_{i-1} \times \left(1 - \frac{\text{WAD}}{100} - \frac{\text{WAC}}{100}\right) \quad [51]$$

where WFR_1=1, WAD is the wether adult death percentage (%), and WAC is the wether adult cull percentage (%). The number of wethers ($WAgeDist_i$) distributed across ages for i = 1 to MaxSA is calculated as follows:

$$\text{WAgeDist}_i = \frac{\text{WFR}_i}{\sum_{i=1}^{\text{MaxSA}} \text{WFR}_i} \times \text{TW} \quad [52]$$

where WFR_i is calculated using Eq. [51] and TW is the total number of wethers in the flock. The number of wethers distributed at the start of year 1 (i.e., i = 0) is calculated as follows:

$$\text{WAgeDist}_0 = \frac{\text{WAgeDist}_1}{1 - \frac{\text{WAD}}{100} \times \frac{1}{2}} \quad [53]$$

The number of replacement wethers required (ReplacementWReq) is calculated as follows:

$$\text{ReplacementWReq} = \text{WAgeDist}_1 \quad [54]$$

where $WAgeDist_1$ is calculated using Eq. [52]. The wether flock percentage ($FlockPer_i$, %) for i = 1 to MaxSA is calculated as follows:

$$\text{FlockPer}_i = \frac{\text{WAgeDist}_i}{\text{TW}} \times 100 \quad [55]$$

where $WAgeDist_i$ is calculated using Eq. [52] and TW is described in Table 5. The number of wethers culled for age sold (WCullForAgeSold) and the number of other culls sold (WOtherCullsSold) are calculated as follows:

$$\text{WCullForAgeSold} = \text{round}\left[(1 - \frac{\text{WAD}}{100}) \times \text{round}\left[\text{WAgeDist}_{\text{MaxSA}}\right]\right] \quad [56]$$

$$\text{WOtherCullsSold} = \text{round}\left[\frac{\text{WAC}}{100} \times \sum_{i=1}^{\text{MaxSA}} \text{WAgeDist}_i\right] \quad [57]$$

where WAD and WAC are described in Table 5, and $WAgeDist_i$ is calculated using Eq. [52].

ImPack allows the user to explore a wide range of options to manage drought conditions; up to three management options can be compared. For example, a producer may have sold half the breeding herd to reduce feeding costs during drought. They could then compare an option to purchase breeding stock after the drought with an option where they allow the breeding numbers to increase slowly and buy and sell trading stock to use excess pasture resources.

PlanPack

PlanPack, a 22-page interactive Microsoft Word document, is designed to help producers develop their drought plan. Drought Pack, FSA Pack, and ImPack can be used to answer questions in PlanPack. Other important factors—for example, water quantity and quality, labor supply, on-farm fodder supply, and personal issues—are entered into PlanPack as the user proceeds through the development of the drought plan. Support material to complete the drought plan is available in the Producer Manual or on the resources CD that are supplied to participants of StockPlan workshops.

RESULTS AND DISCUSSION

Droughts within Australia are often frequent and severe (Crowder, 2000). It is, therefore, paramount that management options are explored before dry spells and during drought. The increase in StockPlan participants (Fig. 2) is indicative of the severe drought that occurred during the 2006 and 2007 summer period.

Exploring management options before dry spells and during drought is strongly emphasized in the StockPlan workshop. The key elements from the Bryceson and White (1994) workshop and the independent Rural Needs and Climate Variability Final Report (1997) highlight that strategies for drought preparedness and tools for making on-farm management are critical to assisting producers to reduce associated risks. Four DST have been developed and integrated into the StockPlan workshop. Tables 6 to 16 report the evaluation of the equations used in the Drought Pack, FSA Pack, and ImPack DST.

The Drought Pack Eq. [1] to [13] calculate the TotalAsFed required to maintain or grow animals at a specified growth rate. The cost of feeding is then calculated and used to calculate a break-even price. The results of dry and pregnant ewes maintained at maintenance (i.e., 0 LWG) and weaned lambs growing at 50 g d^{-1} over a 5-month period are presented in Table 6 and the results of dry and pregnant cows maintained at maintenance (i.e., 0 LWG) and weaned calves growing at 0.6 kg d^{-1} during a 5-month period are presented in Table 7.

The FSA Pack Eq. [14] calculates the expected value (AU$) for each management option (sell, feed, or agist) and time period (short, medium, long, worst case) based on the user determined probabilities of a drought ending within a specified number of weeks. The results of a drought ending in 8, 16, 24, or 40 weeks are presented in Table 8.

The ImPack Eq. [15] to [33] calculates the cow breeding rate and age distribution to determine the herd structure. The ImPack inputs are presented in Table 9 and the outputs are presented in Tables 10 and 11. The CCR, CGR, and CPR Eq. [15] to [17] (Table 10) are critical equations to the calculation of the herd structure, namely, CBR, CAgeDist, and herd percentage of cows joined across ages (Table 11).

The ImPack Eq. [34] to [50] calculates the ewe breeding rate and age distribution to determine the ewe flock structure. The ImPack inputs are presented in Table 12 and the outputs are presented in Tables 13 and 14. The ELR, EGR, and EPR Eq. [34] to [36] (Table 13) are critical equations to the calculation of the ewe flock structure; namely, EBR, EAgeDist, and the percentage of ewes joined across ages (Table 14).

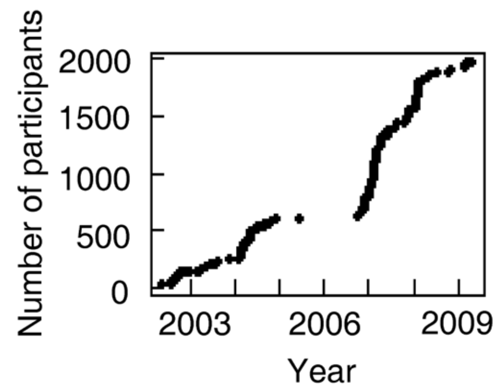

Fig. 2. Cumulative number of StockPlan workshop participants from May 2002 to May 2009.

The ImPack Eq. [51] to [57] calculates the wether flock and age distribution to determine the flock structure. The ImPack inputs and outputs of wether replacement requirements, cull for age, and other culls are presented in Table 15, and the wether flock age distribution and flock percentage are presented in Table 16.

Failure to explore drought management options has the potential to impact pasture availability. Reducing stock numbers or selling stock during dry spells and droughts impacts a producer, and ultimately the rural economy (Gillard and Monypenny, 1990; Stafford Smith and Foran, 1992). In particular, pasture degradation due to over grazing causes long-term damage and consequently impacts the financial viability of a producer. Re-establishing improved pastures is expensive (≈AU$200 ha^{-1} to AU$300 ha^{-1}). In addition, producers suffer a further loss because pasture cannot be grazed during re-establishment.

To address regional issues, any one of the four DST may help producers make a management decision. For example, Drought Pack may be used to determine the break-even point for a particular class of stock in one farming region, but in another region FSA Pack may be used to analyze the long-term impact of stock reduction during drought. Any combination of the StockPlan DST may be used to assist in planning a drought strategy or making a management decision. However, relative risk factors vary among farming regions (Thompson and Powell, 1998).

The StockPlan workshop is a participatory learning experience on how to reduce the financial and social burdens that arise during dry spells and drought. On-farm participatory research has been advocated in the past (McCown et al., 1998, McCown, 2001, 2002) and even though this workshop is not on-farm it does reach out to producers in a participatory format that is led by advisers not researchers. Participatory learning approaches as outlined by Newman et al. (2000) are central to the benefits that producers receive. The StockPlan approach strongly focuses on the adviser taking a lead role rather than the researcher.

The value of a DST should not be under-estimated; for example, livestock extension advisers who know their district can help producers address the issue they may be facing with one of the StockPlan DST. The key to success lies in the hands of those who present a StockPlan workshop. Attending a StockPlan workshop is critical in understanding how the packages can be used. The workshop has the potential to address issues that are relevant for a producer within a district.

Table 6. Inputs and outputs of a Drought Pack analysis of calculating a break-even price for dry and pregnant ewes (Example 1) and for weaned (stock not suckling) lambs (Example 2) using Eq. [1] to [13] for a sheep enterprise based on value of stock, cost of feed, and interest forgone.

		Example 1	Example 2
Items	Range	Value	Value
Inputs			
Value† dry ewe on 1 March, AU$ ewe^{-1}		80.00	–
Value pregnant ewe on 1 March, AU$ ewe^{-1}		90.00	–
Value weaned lamb on 1 March, AU$ lamb^{-1}		–	60
Costs head^{-1}, AU$		2.00	0.70
Planning months‡	1 to 12	5	5
Live weight§, kg	10 to 100	50	21, 23, 25, 27, 29
Live weight gain, g d^{-1}	–50 to 350	0	50
Feed available: oats			
DM, %	1 to 100	89	89
Energy, MJ ME kg^{-1}		12.0	12.0
Cost t^{-1}, AU$		190	190
Feeding out cost t^{-1}, AU$		20	20
Supplement¶, %		100	100
Outputs			
Animal class: dry ewes			
Interest forgone on sale#, AU$ ewe^{-1}		3.05	–
Interest on feeding#, AU$ ewe^{-1}		0.62	–
As-fed, kg DM d^{-1}		0.65	–
Cost of feeding††, AU$ ewe^{-1}		16.38	–
Break-Even Price‡‡, AU$ ewe^{-1}		102.05	–
Animal class: pregnant ewes			
Interest forgone on sale#, AU$ ewe^{-1}		3.43	–
Interest on feeding#, AU$ ewe^{-1}		0.82	–
As-fed, kg DM d^{-1}		0.87	–
Cost of feeding††, AU$ ewe^{-1}		21.91	–
Break-Even Price‡‡, AU$ ewe^{-1}		118.16	–
Animal class: weaned lamb			
Interest forgone on sale#, AU$ lamb^{-1}		–	2.28
Interest on feeding#, AU$ lamb^{-1}		–	0.62
As-fed, kg DM d^{-1}		–	0.47, 0.49, 0.51, 0.54, 0.56
Cost of feeding††, AU$ lamb^{-1}		–	16.19
Break-Even Price‡‡, AU$ lamb^{-1}		–	79.79

† Value of ewe and lambs as at 2012 prices.

‡ Inital month was March.

§ Ewe was dry from March to June and pregnant in July; live weight was set at the same weight across all months for ewes.

¶ Only oats was fed as a supplement.

Interest on money borrowed and invested 9 and 4%, respectively.

†† Total cost of feeding (cost of feed + cost of feeding out) across the planning period (for dry ewe at end of June = 4 × 30 × (0.65 × 0.19 + 0.65 × 0.02); for pregnant ewe at end of July 4 × 30 × (0.65 × 0.19 + 0.65 × 0.02) + 30 × (0.87 × 0.19 + 0.87 × 0.02).

‡‡ Break-even price = value + costs per head + interest forgone on sale + interest on feeding + cost of feeding. Note: differences between Drought Pack output and actual calculations in Excel exist due to rounding errors.

Managers must be aware of the limitations of the StockPlan DST. All of the DST in StockPlan do not take into account the dynamics of a system; for example, Drought Pack is based on empirical ME equations in predicting feed requirements for sheep (g DM d^{-1}) and cattle (kg DM d^{-1}). Also selecting supplementary feeds high in protein to calculate feed requirements is a limitation of the program. The empirical ME equations in Drought Pack also assume that after a dry spell, the land is equally productive regardless of the strategy used. If a higher level of precision is required, then a DST such as GrazFeed (Freer et al., 1997; GrazFeed, 1998) with daily estimates of intake should be used.

Incorrect management decisions based on limited information during a dry spell or drought can lead to stock losses, excessive expenditure for feed, and extensive environmental damage to pastures that impacts the financial viability of rural communities. Management decisions based on sound information early in a dry spell can reduce the associated losses of stock and pasture degradation due to over stocking. The StockPlan workshop provides managers with the information and confidence to assist in making better decisions when faced with a prolonged dry spell or impending drought. For example, within the Australian sheep industry, the decline in flock numbers (ABARE, 2006) has made it more difficult to purchase replacement ewes, and the cost of replacements imposes financial difficulty on the rural community. Therefore, the decision to feed, sell, or agist is a difficult one to make and the drought management strategy used in a previous drought may not necessarily be the best strategy.

An independent survey (Coutts and Sampson, 2007) of StockPlan users was conducted to determine whether producers used lot feeding (i.e., utilizing a paddock to supplementary feed stock). This independent survey was targeted at producers who attended the StockPlan workshop. A brief summary of this data was reported (McPhee et al., 2011). However, the survey (1) allowed multiple choices; and (2) did not include producers who did not attend the StockPlan workshop. A well-planned survey would report on the use and benefits of attending a StockPlan workshop. Nevertheless, the use and benefits are demonstrated in three

Table 7. Inputs and outputs of a Drought Pack analysis of calculating a break-even price for dry and pregnant cows (Example 1) and for weaned (stock not suckling) calves (Example 2) using Eq. [1] to [13] for a cattle enterprise based on value of stock, cost of feed, and interest forgone.

		Example 1	Example 2
Items	Range	Value	Value
Inputs			
Value† dry cow on 1 Mar, AU$/cow		650.00	–
Value pregnant cow on 1 Mar, AU$/cow		650.00	–
Value weaned calf on 1 Mar, AU$/calf		–	470
Costs/head, AU$		0	10.00
Planning months‡	1 to 12	5	5
Live weight§, kg	5 to 700	480	230, 248, 266, 284, 302
Live weight gain, kg d^{-1}	−1.0 to 2.0	0	0.60
Feed available: oats			
DM, %	1 to 100	89	89
Energy, MJ ME kg^{-1}		12.0	12.0
Cost t^{-1}, AU$		190	190
Feeding out cost t^{-1}, AU$		20	20
Supplement¶, %		80	90
Feed available: hay			
DM, %	1 to 100	89	89
Energy, MJ ME kg^{-1}		9.0	9.0
Cost t^{-1}, AU$		120	120
Feeding out cost t^{-1}, AU$		20	20
Supplement¶, %		20	10
Outputs			
Animal class: dry cows			
Interest forgone on sale#, AU$ cow^{-1}		24.74	–
Interest on feeding#, AU$ cow^{-1}		3.53	–
As-fed, kg DM d^{-1}; 3 months		5.31	–
Cost of feeding††, AU$ cow^{-1}		93.67	–
Break-Even Price‡‡, AU$ cow^{-1}		771.94	–
Animal class: pregnant cows			
Interest forgone on sale#, AU$ cow^{-1}		24.74	–
Interest on feeding#, AU$ cow^{-1}		6.59	–
As-fed, kg DM d^{-1}; 2 months		6.91	–
Cost of feeding††, AU$ cow^{-1}		174.93	–
Break-even price‡‡, AU$ cow^{-1}		856.26	–
Animal class: weaned calf			
Interest forgone on sale#, AU$ $calf^{-1}$		–	17.89
Interest on feeding#, AU$ $calf^{-1}$		–	5.57
As-fed††, kg DM d^{-1}		–	4.40, 4.60, 4.90, 5.10, 5.30
Cost of feeding‡‡, AU$ $calf^{-1}$		–	146.33
Break-Even Price§§, AU$ $calf^{-1}$		–	649.79

† Value of cow and calf as at 2012 prices.

‡ Inital month was March.

§ Cow was dry from March to May and pregnant in June and July; live weight was set at the same weight across all months for cows; live weight at the beginning of the month for subsequent months in Example 2 were calculated as follows: 248, 266, 284, and 302 kg.

¶ Supplement split between oats and hay.

Interest on money borrowed and invested 9 and 4%, respectively.

†† As-fed values calculated for each month.

‡‡ Total cost of feeding (cost of feed + cost of feeding out) across the planning period (for dry ewe at end of June = 3 × 30 × [0.80 × (5.31 × 0.19) + 0.20 × (5.31 × 0.12) + 5.31 × 0.02]; for pregnant cow at end of July 3 × 30 × [0.80 × (5.31 × 0.19) + 0.20 × (5.31 × 0.12) + 5.31 × 0.02] + 2 × 30 × [0.80 × (6.91 × 0.19) + 0.20 × (6.91 × 0.12) + 6.91 × 0.02].

§§ Break-even price = value + costs per head + interest forgone on sale + interest on feeding + cost of feeding. Note: differences between Drought Pack output and actual calculations in Excel exist due to rounding errors.

case studies reported in a companion paper (Whelan et al., 2013) on Drought Pack, FSA Pack, and ImPack.

The StockPlan workshop has the potential to help cattle, sheep meat, and wool producers improve drought management decisions and develop drought plans (i.e., drought preparedness) during dry spells and drought. The StockPlan workshop was developed using a team approach, which crossed a number of disciplines. The approach taken—inclusion of stakeholders (i.e., pilot workshops with producers), resources (extension, production modeling, economics, and computing skills), and scientific ideas integrated into an effective decision support framework are similar to the lessons learned from an integrated modeling approach to supporting sustainable water resources (Liu et al., 2008) and the lessons learned from the FARMSCAPE approach (McCown et al., 1998). The integration of the four DST (Drought Pack, FSA Pack, ImPack, and PlanPack) into the StockPlan software helps managers address a number of issues in the early stages of a dry spell or during drought. Fostering drought preparedness is critical and the StockPlan workshop has the potential to help managers make informative and timely decisions before the onset of a drought and therefore reduce the environmental and financial impacts on rural communities.

Table 8. Expected values† of feed, sell, or agist for the associated feed costs based on user determined probabilities of a drought ending within a specified number of weeks for short, medium, long, or worst case scenarios.

Drought ending within	Probability	Feed	Sell	Agist
	%			
8 weeks	85	$23,993	$7,044	$17,543
16 weeks	5	$49,059	$9,520	$16,073
24 weeks	5	$78,387	$13,491	$20,997
40 weeks	5	$141,294	$16,922	$30,872
Expected value	100	$33,831	$7,984	$18,308

† The weighted mean calculated according to the probabilities that were entered for each of the drought time periods.

Table 9. ImPack inputs of maximum age at joining the herd (MaxAJ), total number of cows mated (TCM), cow weaning (CW), cow weaning deaths (CWD), cow adult culls (CAC), cow adult deaths (CAD), cow failed to rear a calf (CFRC), and age of heifers and steers sold.

Item	Value
Inputs	
MaxAJ	10
TCM	100
CW, %	88
CWD, %	3
CAC, %	1
CAD, %	2.5
CFRC, %	83.3
Age heifers sold, years	1
Age steers sold, years	1

Table 10. ImPack outputs of cow calving rate (CCR), cow gestation rate (CGR), cow pregnancy rate (CPR), number of calves required (CalvesReq), calves weaned (stock not suckling) (CalvesWeaned), total dry cows (TotalDryCows), total dry cows sold (TotalDryCowsSold), adult cows sold (AdultCowsSold), heifers sold (HeifersSold), and steers sold (SteersSold).

Item	Value
CCR	0.90
CGR	0.02
CPR	0.92
CalvesReq	16
CalvesWeaned	1
TotalDryCows	8
TotalDryCowsSold	7
AdultCowsSold	5
HeifersSold	27
SteersSold	42

Table 11. ImPack outputs of cow breeding rate (CBR), cow distribution (CAgeDist), and herd percentage (HerdPer) of cows joined across ages.

Ages	CBR	CAgeDist	HerdPer, %
0	–	15.64	–
1	1.00	15.40	15
2	0.90	13.85	14
3	0.81	12.45	12
4	0.73	11.20	11
5	0.65	10.07	10
6	0.59	9.05	9
7	0.53	8.14	8
8	0.48	7.32	7
9	0.43	6.58	7
10	0.38	5.92	6

Table 12. ImPack inputs of maximum age at joining of flock (MaxAJ), total number of ewes joined (TEJ), ewe weaning (stock not cuckling) (EW), ewe weaning deaths (EWD), ewe adult culls (EAC), ewe adult deaths (EAD), and ewe failed to rear a calf (EFRL) percentages.

Item	Value
TEJ	2015
MaxAJ	6
EW, %	90
EWD, %	5
EAC, %	7
EAD, %	5
EFRL,%	75

Table 13. ImPack outputs of ewe calving rate (ELR), ewe gestation rate (EGR), ewe pregnancy rate (EPR), number of lambs required (LambsReq), lambs weaned (stock not suckling) (LambsWeaned), wethers, maidens, cull for age (CFA) ewes, culled ewes (CullEwes), and dry ewes (DryEwes) for a self-replacing flock.

Item	Value
ELR	0.98
EGR	0.02
EPR	0.95
LambsReq	517
LambsWeaned	26
Wethers	861
Maidens	861
CFA Ewes	179
CullEwes	141
DryEwes	70

Table 14. ImPack outputs of ewe breeding rate (EBR), ewe age distribution (EAgeDist), and flock percentage (Flock) of ewes joined across ages for a self-replacing flock.

Ages	EBR	EAgeDist	Flock, %
0	–	503.62	–
1	1.00	491.03	24
2	0.85	414.95	21
3	0.71	350.66	17
4	0.60	296.33	15
5	0.51	250.42	12
6	0.43	211.62	11

Table 15. ImPack inputs of total number of wethers in the flock (TW), maximum shearing age (MaxSA), wether adult culls (WAC), and wether adult deaths (WAD) percentages and ImPack outputs for number of replacement wether requirements (ReplacementWReq), wether cull for age (WCullForAge), and wether other culls (WOtherCulls).

Item	Value
Inputs	
TW	1000
MaxSA	10
WAC, %	2
WAD, %	2
Outputs	
ReplacementWReq	119
WCullForAge	83
WOtherCulls	20

Table 16. ImPack outputs of wether flock rate (WFR), wether age distribution (WAgeDist), and wether flock percentage (Flock) of wethers joined across ages.

Ages	WFR	WAgeDist	Flock, %
0	–	120.55	–
1	1.00	119.34	12
2	0.96	114.57	12
3	0.92	109.99	11
4	0.88	105.59	11
5	0.85	101.36	10
6	0.82	97.31	10
7	0.78	93.42	9
8	0.75	89.68	9
9	0.72	86.09	9
10	0.69	82.65	8

IMPLICATIONS

StockPlan, an accredited PROfarm course conducted by NSW Department of Primary Industries, integrates four decision support tools (Drought Pack, FSA Pack, ImPack, and PlanPack) that help managers address a number of issues in the early stages of a dry spell or during drought. Fostering drought preparedness is critical. Attendance at a StockPlan workshop has the potential to help cattle, sheep meat, and wool producers achieve benefits that reduce the environmental and financial impacts on rural communities. The interaction between workshop leaders and participants is a critical process in achieving benefits from the StockPlan workshop.

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