1 Introduction

The Maori word for New Zealand is Aotearoa, and a literal translation of the term is “the land of the long white cloud”. This sets the context for this chapter as those familiar with farming will know that clouds (rain or imminent rain) are excellent for forage production and pastoral farming. They’re not so good for crop production. So, pasture as forage is New Zealand’s dominant crop, and it provides the feed input to dairy, sheep, beef, deer, and goat producers.

From a POM perspective, the challenges created by livestock farming are universal with respect to livestock inventory (this inventory that can age, die, and reproduce). However, with pastoral farming systems, it is the input inventory that has its unique challenges. Determining how much feed is available is the first challenge as that is a factor of pasture growth rates that is affected by rainfall, soil temperature, and previous management of the sward. Planning for feed to match the known demand from breeding and finishing livestock is, therefore, fraught with uncertainty and requires a wide range of contingency plans in case the feed is either not there or there in abundant quantities at diminishing quality. This chapter takes a specific focus on feed inventory management in order to illustrate the challenges to POM that exist in pastoral farming and the methods that New Zealand farmers use to overcome them.

2 Normative Versus Descriptive Research

Management can be studied from two viewpoints in the context of farming: normative and descriptive (Ilbery 1978). Normative studies seek to determine how a rational person would make decisions in a given situation and to provide prescriptive advice on how best to make decisions. Normative research on the management and decision-making processes dominated the farm management literature through until the 1990s (Jacobsen 1993; Ohlmer et al. 1998; Rougoor et al. 1998). During this time, numerous authors have argued that greater emphasis should be placed on descriptive research and that until this occurs, and the gap between theory and practice is closed, farmers will continue to view much of the farm management research as irrelevant (Ohlmer 1998; Rougoor et al. 1998; Nuthall 1999). For example, Nielson (1961) was concerned that much of the theory in farm management was based on agricultural economics and that this had resulted in a largely normative research approach, that is, the focus was on what managers ought to do, rather than what they actually do.
Despite this and other similar criticisms (Johnson 1963; Burns 1973; Jackson 1975; Nix 1979; Andison 1989; Malcolm 1990) made throughout the history of the discipline, it is only within the last few decades that the processes used by farmers to make management decisions has been researched (e.g., Jacobsen 1993; Ohlmer 1998; Rougoor et al. 1998; Nuthall 1999). Although the early descriptive work of Johnson et al. (1961) challenged some of the normative views of management at the time, the impact of this study on United States agriculture was not great. In fact, farm management research in the United States has remained predominantly normative in nature. In contrast, European researchers developed this area through the 1990s (Attonaty and Soler 1991; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998; Ohlmer et al. 1998). This more recently emerged descriptive research into farm management has enriched the discipline and some of the research in this area in relation to tactical management is described in the following sections in relation to pastoral farming in New Zealand.

In the following sections, the tactical management processes used by pastoral-based livestock farmers is described and compared with the literature, both normative and descriptive. The planning processes used by farmers are discussed. The product of farmers’ planning processes, the plan, and its components: goals, predictive schedule of events, targets, and contingency plans are compared with other reported research. Aspects of the control process that are compared with the literature include the monitoring process, decision point recognition, diagnosis, and control response selection.

### 3 Tactical Management Process

The tactical management process used by farmers can be represented as a cyclical process of planning, implementation, and control, in much the same manner as proposed by Barnard and Nix (1979) and Boehlje and Eidman (1984). While the process is cyclic, planning decisions are made irregularly (Figure 25.1), and the ratio of implementation to control decisions is a function of the level of uncertainty in the environment. This model is more useful than the decision-making model (Hardaker et al. 1970; Osburn and Schneeberger 1983; Kay 1981; Boehlje and Eidman 1984), which fails to capture the importance of management control. The model reported here is similar to those reported in the descriptive tactical management literature (Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998). In essence, farmers have a plan, implement it, and then use control decisions or “regulations” (Aubry et al. 1998) to manage deviations from the plan due to uncertainty in the environment.

![Figure 25.1](source: Adapted from Gray 2001)
As proposed by Simon (1960) and Gorry and Morton (1971), the tactical decisions made by farmers are predominantly “structured” in nature. It was only under extreme conditions or where a new input or management practice was used that farmers use less structured decision-making processes. In these instances, rather than automatically drawing on their heuristics to select a plan or control response, farmers either undertake a less “structured” planning process, or in the case of control decisions, diagnostic and/or evaluation processes are used that lead to learning and the introduction of a new control response. These “unstructured” decisions are analogous to Scoullar’s (1975) problem-solving process that he proposed managers would use in novel situations, where a knowledge, rather than a performance gap existed.

Little useful information is provided in the normative literature on how to determine the planning horizon for a particular plan. Other than suggesting that tactical plans should have shorter planning horizons than strategic plans (Wright 1985), the literature suggests that decisions on the planning horizon be left to the manager's judgement (Reisch 1971; Hanf and Schiefer 1983; Wright 1985). Hanf and Schiefer (1983) also highlighted the trade-off that occurs between reducing uncertainty and lessening the manager's appreciation of longer-term consequences as the planning horizon is shortened.

Both the criteria used for setting their planning horizons, and the means by which the problem of interdependency and consequences was overcome, has been identified for farmers. A farmer's planning horizon primarily reflects seasonal changes in the physiological state of the pastures, the balance between pasture growth and livestock feed demand and the goals associated with these changes. Similar results were reported by Mathieu (1989), who found that on a French pastoral farm in the Jura Mountains, the year could be separated into three phases on the basis of relative pasture growth rates, which are a function of the physiological status of the sward and the climate. Other descriptive studies (Gladwin 1979; Cerf et al. 1993; Siddiq and Kundu 1993) have reported the importance of climate to the annual calendar of operations adopted by farmers, but they have not discussed this in relation to planning horizons.

Some farmers also used a critical event, calving, to reduce the length of their mid-year planning horizon and simplify the planning process. Proximity to a critical event (e.g., drying off) also influences farmers' choice of the plan termination date. Because farmers’ planning horizons are primarily a function of seasonal changes in the feed balance, each period has different goals and associated tasks for achieving these goals. Similarly, Cerf et al. (1993) reported that farmers separated the year into different periods according to the tasks required for production. For farmers, extreme climatic conditions (dry spring, early autumn rains) that shifted the seasonal change-point, precipitated modifications to their planning horizons. A strategic decision such as changing farms could also prompt a change in planning horizon.

Farmers have developed a simple means of overcoming the problem of interdependency and consequences (Reisch 1971; Kennedy 1974; Hanf and Schiefer 1983). Within the plan, they set terminating targets that specified the farm's state at the end of each planning horizon. These terminating targets are designed to ensure optimum system performance, ceteris paribus, in the next planning period. The targets are selected on the basis of the farmer's knowledge of cause-and-effect relationships in system performance and ensured short-term gains were not obtained in the current planning period at the expense of longer-term production.

Rather than undertake a full planning process at regular intervals, farmers developed a plan at the start of each planning period and then used the control process to cope with uncertainty. This achieved the same outcome as the rolling planning process (Kennedy 1974; Hanf and Schiefer 1983) but reduced the input required by farmers. Plans are revised, but on an irregular basis in response to strategic decisions, extreme conditions, or the imminence of a critical decision (e.g., drying off).
Previous authors’ (Kennedy 1974; Jolly 1983; Wright 1985; Parker 1999) criticism of the farm management discipline’s focus on planning to the detriment of control is well supported by empirical research into farmer practice. Farmers spend limited time on tactical planning, instead relying on control in order to cope with uncertainty in the environment. These findings support the view of Wright (1985) and Kaine (1993) that in situations where uncertainty is high, greater emphasis will be placed on control relative to planning. The interdependence of planning and control (Anthony 1965) was demonstrated by Gray (2001) who identified that important components of his case farmers’ plans were essential for control: these were their targets (or standards) and associated contingency plans and decision rules. A case farmer is the farmer that was investigated during a case study.

3.1 The Planning Process

Farmers in New Zealand have been found to use either (i) “informal and qualitative” or (ii) “formal and quantitative feed budgeting” approaches to planning. Other farmers have been found to alternate between the two (Gray et al. 2003). Most of the literature has tended to identify farmers as using one approach or the other. The work of Gladwin (Gladwin and Murtaugh 1980; Gladwin and Butler 1984) and that of the French (Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998) suggested that farmers used an informal qualitative heuristic-based planning approach. Other studies (Jacobsen 1993; Ohlmer et al. 1998; Catley et al. 2000) also found that the majority of farmers used an informal qualitative approach and that few developed formal written plans for their farms. Similarly, survey research (Parker et al. 1993; Nuthall 1996; Nuthall and Bishop-Hurley 1999) has tended to report on the use—or non-use—of formal quantitative planning approaches by farmers. However, this research has not explored the transition from one approach to the other. The other interesting point was that, although budgeting is widely recognized in the discipline as an important planning aid for resource allocation (Barnard and Nix 1979; 1983; Osburn and Schneeberger 1983; Kay and Edwards 1994), to the point that Boehlje and Eidman (1984) referred to it as a “fundamental planning tool”, it was only used for part of the year by high-performing farmers in a study by Gray et al. (2003). During the spring and summer, farmers in the study by Gray et al. (2003) argued that they perceived no additional benefit to formal planning, particularly given the high level of uncertainty over this period relative to what they currently did. Rather, the additional planning and pasture measurement would incur additional time costs.

3.1.1 Informal Planning Process

Similar to the process described in several other studies (Gladwin and Murtaugh 1980; Gladwin and Butler 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998), New Zealand pastoral farmers use a predominantly informal, qualitative, and heuristic-based planning process. However, as seen in Figure 25.2, some important differences were identified. The “typical” plan was modified in response to prior learning, a form of historical control, previously made strategic and “atypical” tactical decisions, and the state of the farm at the start of the planning period. The state of a farm at the start of a planning period can have a major influence on the structure of a farmer’s plan (Figure 25.2). For example, at the start of the summer in a study by Gray (2001), the state of the farm was quantified in terms of the pasture, supplement, forage crop, and herd resources. If the farm state was fairly typical for that time of year, then the “typical” plan was implemented. This process was largely subconscious. However, if the farm state was significantly different from normal for that time of year (e.g., due to drought), the case farmers
Modify the “typical” plan in relation to these improvements

Have improvements to the “typical” plan been identified since the last planning?

Yes

Modify the “typical” plan in relation to these improvements

No

Modify the “typical” plan in relation to the strategic changes

Have strategic changes been made that impact on the “typical” plan?

Yes

Modify the “typical” plan in relation to the strategic changes

No

Have atypical tactical decisions been made in the previous planning period that will affect the “typical” plan?

Yes

Modify the “typical” plan to account for the “atypical” tactical decisions

No

Has the market outlook changed significantly for particular stock classes?

Yes

Modify the “typical” plan to account for the change in markets

No

Assess farm state (pasture, supplement, forage crop, and livestock resources)

Assess if “typical” or modified “typical” plan is feasible

“Typical” plan is feasible

“Typical” plan is infeasible

Adjust “typical” or modified “typical” plan

Adjust the plan

Test feasibility of modifications using mental simulation

Is modification feasible?

Yes

Adjust the plan

Implement plan

Plan Modification Sub-process

Postulate suitable modifications

Figure 25.2 The Informal Planning Process Used by Farmers

Source: Gray 2001
knew that their typical plans would not be feasible. In this situation, they proposed some changes to the plan in relation to their planning heuristics (sequence and timing of events, level, and type of inputs, and target selection) so that their summer goals for the plan would be met. A mental simulation was then run to test the efficacy of the changes. If the adjusted plan proved feasible, it was implemented. If not, further changes were investigated. Sometimes this iterative process was completed over several days. The time taken was dependent on the nature of the farm state and the severity of the changes required to achieve the summer goals. This problem was compounded if a major change to the typical plan had already been made due to strategic or historical control reasons. A more formal quantitative approach to planning was used in such situations. These results suggest that farmers have a broadly defined set of conditions within which their “typical” plan is robust, but if conditions fall outside this range, the plan is modified.

Gray (2001) reported that the planning process used by the farmers in his study for a “typical” year was largely subconscious or “pre-attentive” (Gladwin and Butler 1984) and as such, it avoided the cognitive effort and stress involved in more formal planning (Gladwin and Murtaugh 1980; Gladwin and Butler 1984). This finding supports the views of Simon (1960) as well as Gorry and Morton (1971) that effort declines as decisions become more structured and that this structuredness eventuates from the repetitive nature of the decisions, a factor more likely to occur at the tactical and operational than the strategic level of decision making.

3.1.2 Formal Planning Process

The “expert” farmers in Gray’s (2001) study changed from an informal qualitative to a formal quantitative planning approach in autumn. In the literature, however, farmers have been classified as either using or not using formal quantitative planning approaches rather than both (Parker et al. 1993; Nuthall 1996; Ohlmer et al. 1998; Nuthall and Bishop-Hurley 1999). A relatively simple planning aid, a feed budget, provided assistance to the planning process but required a series of “pre-decisions” to be made, as also described by Reisch (1971), before the mechanical process of computation began. It also highlights why Wright (1985) distinguished the cognitive process a manager undertakes when developing a plan from the use of planning aids. The effective use of planning aids depends upon the user’s knowledge of the planning process and their production system. Someone with limited knowledge and experience of pastoral systems (a novice) would struggle to use a simple feed budget effectively.

The farmers in Gray’s (2001) study believed that the feed budget enhanced a manager’s planning process and resultant plan. Given the importance of the planning period in this study, the low capital and time cost (up to one hour), and the usefulness of the planning aid, the low adoption rate of formal feed budgeting by New Zealand pastoral farmers (Parker et al. 1993; Nuthall 1996; Nuthall and Bishop-Hurley 1999) is surprising. This is especially so, given Wright’s (1985) belief that planning effort is proportional to the perceived net benefit from planning. However, there is another cost associated with formal feed planning, and that is the need for a two to three-hour pasture walk every five to fourteen days for control purposes. This increases the “cost” when compared to the much quicker informal visual assessment practiced by farmers. Survey data supports farmers’ preference for non-formal approaches, with the most important reason given for non-adoption being the time requirements of formal feed planning and monitoring (Nuthall and Bishop-Hurley 1999).

In the study by Gray (2001), the farmers had a good understanding of the likely range of conditions they could expect. Contingency plans were “stored” mentally as could be expected given the tactical nature of the plans and the expertise of the case farmers. Other studies (Gladwin and Murtaugh 1980; Gladwin and Butler 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al.
POM in Agriculture: Pastoral Farming

1996; Aubry et al. 1998) have also reported that farmers have pre-defined contingency plans, which are activated when conditions deviate from the plan as proposed by Boehlje and Eidman (1984). Importantly, farmers have contingency plans to deal with both upside and downside risk and they tend to rank them in terms of priority of use (as seen in Table 25.1) (Gray et al. 2006).

The farmers in Gray’s (2001) study used the final step in the formal planning process, the modification of plans in the light of control results (Barnard and Nix 1979; Boehlje and Eidman 1984), during both the summer and autumn to cope with uncertainty. Several authors (Reisch 1971; Kennedy 1974; Hanf and Schiefer 1983; Jolly 1983; Boehlje and Eidman 1984; Wright 1985) have argued that control and plan revision are important because of the dynamic nature of the planning process. Results from other similar studies (Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998) support this view. The case farmers in Gray’s study (2001) did not formally analyze or account for risk in their planning procedures. For example, as reported by researchers such as Gladwin (1989) and Ohlmer et al. (1998), these farmers did not use probabilities to assess the level of risk associated with alternative plans. One farmer used conservative pasture growth rates to provide some flexibility, and both case farmers retained silage (maize or grass) in reserve to cope with extreme conditions. Risk was mainly managed through the farmers’ control process. A wide choice of options provided them with the flexibility to cope with deviations from the plan.

In a study of an expert sheep and cattle farmer, Gray et al. (2006) found that the farmer uses an iterative feed planning process to develop the feed plan (as seen in Figure 25.3). The process begins in January when the farmer determines which areas will be allocated to sheep and cattle for the spring. The cattle are allocated the easier contour country and the sheep the steeper country. The farmer decides, on the basis of the performance of these blocks over the last twelve months, whether they are growing more grass than in the past. If he thinks the blocks are producing more pasture, he will adjust the spring stocking rate accordingly for each stock class. For example, in year one of the study, the farmer believed his cattle country was growing

<table>
<thead>
<tr>
<th>Feed Deficit</th>
<th>Feed Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Feed Demand</td>
<td>Increase Feed Supply</td>
</tr>
<tr>
<td>1. Reduce intake of R2yr bulls</td>
<td>1. Feed balage reserve</td>
</tr>
<tr>
<td>2. Place R2yr bulls in the pine plantation</td>
<td>2. Feed forage crop earlier</td>
</tr>
<tr>
<td>3. Reduce dry hogget intake</td>
<td>3. Apply urea early</td>
</tr>
<tr>
<td>4. Sell 100 “surplus” dry hoggets</td>
<td>4. Apply additional urea</td>
</tr>
<tr>
<td>5. Reduce single-bearing ewe intakes late winter</td>
<td></td>
</tr>
<tr>
<td>6. Reduce intake of tail end R1yr bulls</td>
<td></td>
</tr>
<tr>
<td>7. Sell R2yr cattle</td>
<td></td>
</tr>
</tbody>
</table>

Source: Gray et al. 2006
more pasture than in the past and as a result, he decided to increase his cattle stocking rate by 0.8–1.0 csu/ha (cattle stock unit per hectare). If the farmer does not believe the blocks are producing more pasture than normal, he will use the same spring stocking rate as in the previous year.

Once the block area and stocking rates are determined, the farmer calculates, given his desired ratio of older to younger cattle, how many cattle he can winter (Figure 25.3). He then estimates the likely lambing percentage for the ewes based on their current live weight relative to historical data and expected feed conditions through autumn. This information is then used

Figure 25.3  The Feed Planning Process Used to Develop the Winter Plan
Source: Gray et al. 2006
to estimate the proportion of triplet-, twin-, and single-bearing ewes that would be on-hand at
set stocking ten days prior to the start of lambing. From this, given his stocking rate assumptions
and the allocated sheep area, the farmer works out how many sheep he can winter. The feasibility
of this initial plan is then tested by estimating the feed demand of each stock class from
set stocking to lambing and then from lambing to balance date to determine if the expected
pasture growth rates will be sufficient to match feed demand and meet the pasture cover targets
for balance date (Figure 25.3). If the plan does not appear feasible, adjustments will be made to
stock numbers.

In the next step in the process (Figure 25.3), the farmer completes a formal feed budget (using
an Excel spreadsheet developed by a local consultant) for the period late March to balance date in
late September to further test the feasibility of the plan and estimate the level of average pasture
cover required at May 1st to make the plan work. If the plan is not feasible because there is an
insufficient amount of feed on-hand, alternative plans using additional nitrogen or delaying the
purchase of cattle in late winter and early spring are investigated. If the plan suggests surplus feed
is available, the farmer will investigate options such as retaining cattle for longer before sale and/
or reducing autumn nitrogen inputs. On May 1st, when the farmer has a clearer idea of the feed
and market situations, the feed budget is revised. The outcome from the planning process, the
plan, is discussed next.

4 The Plan
The “typical” or “modified typical” plan used by the farmers comprised a set of heuristics
that determined the activities, their sequence and timing, the type and level of inputs, and the
intermediate targets in the plan (Gray et al. 2003). In effect, they reflect the cognitive processes
farmers have to undertake to develop their “typical” plan over time. Wright (1985) believed that
these cognitive processes are central to planning. The heuristics used for planning by farmers
could be classified into the categories identified by Aubry et al. (1998): sequencing, activation
and termination or time range, arbitration, and mode establishment decision rules. The sequencing
rules could be further subdivided into obligatory and non-obligatory heuristics. Similarly, the
mode establishment decision rules could be separated into type, level, and combination of input
determining heuristics. Limited evidence of grouping rules (Aubry et al. 1998) was found in
the study by Gray (2001). Unlike cropping (e.g., Aubry et al. 1998), and the more diverse alpine
pastoral livestock farms (e.g., Fleury et al. 1996), the case farmers tended to treat their paddocks
as homogenous entities over the summer-autumn in the study by Gray (2001). Target selection
heuristics, not identified by Aubry et al. (1998) were used by farmers to select intermediate and
terminating targets for control purposes.

Farmers’ knowledge of cause and effect relationships within the production system and the
short- and long-term consequences of their actions formed the basis for the development of plan-
ing heuristics (Gray 2001). This corresponds with Papy’s (1994) view that interaction occurs
between a farmer’s knowledge model and their plan (action model) and that this interaction is
two-way. The planning heuristics used by farmers appears to be based on the economic principle
of marginality (Gray 2001), that is, they will adjust inputs to the point at which marginal cost of
the inputs equals the marginal value of the outputs they create. Similar results were reported by
Jacobsen (1993). As with Aubry et al. (1998), the priority of resource use within the farmers’
plans in Gray’s (2001) study was based on the criteria of “impact on final yield”. However, the
farmers were considering the effect, not only in terms of impact on the current, but also next
season’s milk yield, where next season’s yield had priority. A farmer’s concern for longer-term
productivity was also reported by Buxton and Stafford Smith (1996).
The planning heuristics identified by Aubry et al. (1998) make explicit the important planning decisions a farmer must make. These include:

- What activities should be included in the plan?
- How should the activities be sequenced?
- When should an activity be activated and terminated?
- What inputs, or combination of inputs should be used?
- What level of inputs should be used?
- What targets should be set to control the implementation of the plan?

Making these cognitive processes associated with planning explicit enables farmers to reflect on the structure of their own plan and to compare this with those of others. It also provides researchers with a basis for understanding and comparing farmers’ plans, as illustrated by the focus of the French work (Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998).

The plans used by farmers contain five important components: the goals for the planning period, a predictive schedule of events, a set of targets for controlling the implementation of

![Diagram of a Farmer's Plan](image-url)

*Figure 25.4 A Diagrammatic Representation of a Farmer’s Plan*

*Source: Gray 2001*
the plan, a rich set of contingency plans that could be implemented if a deviation from the plan occurred, and a set of decision rules that are used in conjunction with the targets to implement the plan, or if a deviation occurs, implement a suitable contingency plan (as seen in Figure 25.4).

This structure in Figure 25.4 is identical to those reported from several other studies (Gladwin and Murtaugh 1980; Gladwin and Butler 1984; Gladwin et al. 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998) although the terminology is different in several instances. The French (Sebillette 1993; Papy 1994) referred to the plan as a “cognitive action model”. Sebillette (1993) described this as a representation of “the mental image a farmer has of the actions required to attain certain objectives”. Gladwin (Gladwin and Murtaugh 1980; Gladwin and Butler 1984) referred to the plan as a “predefined plan” or “script”. Both identified goals, a predictive schedule of events, and an associated set of intermediate targets as important components of farmers’ tactical plans. Neither made reference to contingency plans. Gladwin (Gladwin and Murtaugh 1980; Gladwin and Butler 1984) called these “embedded sub-plans” and found that farmers used decision rules to determine whether to implement the plan, or one of the “embedded sub-plans”. In contrast, the French (Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998) coined the term “regulations”, which incorporates both the decision rules and the contingency plans.

Implicit within the literature are the components one would expect in a plan. For example, Boehlje and Eidman (1984) discuss the process of planning and mention the need to clarify goals, set out procedures, define targets, and develop contingency plans. However, the nature of what exactly a plan should comprise is not discussed. This is one of the criticisms raised by Reisch (1971) and Wright (1985) of the planning literature in farm management. In the following sections, the components of farmers’ plans that are important for achieving the goals of the planning period are discussed and compared with the literature.

4.1 The Predictive Planning Schedule

Farmers have a “typical” plan that contains a predictive planning schedule of the events or activities to be undertaken to achieve targets (Gladwin and Murtaugh 1980; Gladwin and Butler 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998). Five factors influenced the nature of a farmers’ predictive planning schedule and these accounted for between-year and across-farmer differences: values, strategic decisions, learning, prior tactical decisions, and the state of the farm at the start of the planning period. Values influenced the farmers’ strategic choices, which in turn influenced the structure of the predictive planning schedule. Other authors have reported the influence of values (Gasson 1973) and attitudes towards intensification (Fleury et al. 1996) on farmers’ plans. Gray (2001) found that over a three-year period, one farmer’s predictive planning schedules diverged considerably, primarily as a result of strategic decisions designed to increase feed inputs over the summer-autumn. In contrast, another farmer was prevented from pursuing this approach by his “low-input” philosophy. Through learning (Aubry et al. 1998), new or improved management practices are identified by farmers and introduced into their predictive planning schedules. Prior tactical decisions also influenced the predictive planning decision. The state of the farm at the start of the planning period could precipitate changes to the “typical” plan.

Farmers’ predictive planning schedules have inherent flexibility. Although some activities in a farmer’s plan are date specific (e.g., pregnancy testing, sowing new grass), the timing of most activities is specified by condition-dependent heuristics. The latter reduced the need for plan revision in response to changing conditions, i.e., if conditions were below average, the heuristic
triggered the next event in the plan earlier. Similar results have been found in other descriptive studies (Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998).

4.2 Targets

The third component of a farmer’s plans is their targets (or standards) (Figure 25.5). These were used in two main ways: first to trigger the implementation of the activities specified in the plan and second to identify when the implementation deviated from the plan. In the latter case, suitable contingency plans were adopted to minimize the impact of the deviation. This is the same as the role attributed to targets in the normative (Barnard and Nix 1979; Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994; Parker 1999) and descriptive literature (Mathieu 1989; Fleury et al. 1996; Aubry et al. 1998) although the former tend to only mention their role in relation to deviations from the plan.

As seen in Figure 25.5, a novel typology of target types was developed from a study by Gray (2001). Two main types of targets were used in tactical management: terminating and intermediate. The former were specified at the end of a planning period and acted as “sustainability” constraints in much the same way as Barnard and Nix (1979) described for “husbandry” constraints. In contrast, intermediate targets were applied between the start and end of the planning horizon. Mathieu (1989), Fleury et al. (1996), and Aubry et al. (1998) identified these as intermediate objectives. They can be separated into three types: benchmark dates, milestones, and thresholds. Benchmark dates specify the date at which a certain activity or event must be implemented. Milestones, on the other hand, are projected steps on the way to a final terminating target, for example, intermediate average pasture cover targets. Threshold targets, if exceeded, trigger an activity or event. Aubry et al. (1998) mentioned that farmers used dates and “states of progress of work” to activate events within the plan, or contingency plans, but did not place these in a typology. Mathieu (1989) separated intermediate objectives into production, animal requirement, and forage state targets. She also described “regulations” to adjust forage regrowth speed, and forage regrowth duration, but did not mention targets or objectives for these factors. Intermediate targets were identified for production, animal requirements, forage state, climatic events, and

![Figure 25.5 A Typology of Target Types](Source: Gray 2001)
regrowth duration (rotation length). These had associated benchmark date targets. Some of these can be viewed as sub-categories of the “milestone” and “threshold” categories.

Intermediate targets had three roles: controlling the implementation of the plan, ensuring the terminating targets were met, and optimizing system performance. Except for the first, little mention is made of other roles in the literature, although the third role is often implied (e.g., Parker 1999). Targets changed from one planning period to the next (Gray 2001). Thus, milk production was the primary target for summer, while average pasture cover took over this role in the autumn plan (Gray 2001).

Many of the targets used by farmers are flexible. As Fleury et al. (1996) notes, they could be adjusted to suit the conditions. The adjustment of targets is viewed as a normal control response in the normative literature (Boehlje and Eidman 1984). However, some targets were non-negotiable within a season. These were the terminating conditions for the autumn plan including the targets set for calving or balance date (pasture cover and/or cow condition score). They were non-negotiable because they were critical for ensuring optimum production in the next season. Other studies have identified situations where farmers have negotiable terminating targets (Burrows 2013), but this has consequences for production in the subsequent planning period.

### 4.3 Contingency Plans

Boehlje and Eidman (1984) recommended that farmers prepare a set of contingency plans for different forecasted scenarios. In contrast, farmers’ contingency plans tend to be developed through time from experience (Gray 2001). Farmers have a wide range of options to cope with different conditions and their contingencies tend to be developed to cope with both upside and downside risk. Pastoral farmers tend to face two types of feed situations: a deficit (downside risk) or a surplus (upside risk). As seen in Figure 25.6, two “types” of responses were available for each of these “situations” and these were mirror images of each other. Thus, in a feed deficit situation, farmers can implement contingency plans that would increase feed supply, reduce feed demand, or produce a combination of these responses. In a feed surplus situation, they would do the opposite. These control responses are used in the manner proposed by Makeham and Malcolm (1993) to minimize the impact of adverse situations and exploit favorable circumstances.

Contingency plans were either sourced from existing resources (e.g., cow condition, stored feeds) or externally (e.g., nitrogenous fertilizer, grazing, maize silage, greenfeed maize). The latter

![Figure 25.6 Typology of Contingency Plans Used by Farmers](source: Gray 2001)
increased the farmers’ “system” variety to cope with uncertainty (Dalton 1982). The typology in Figure 25.6 is useful when comparing different pastoral-based systems, and it could be applied to other tactical management fields such as cashflow management, water budgeting, and labor management. However, at a more abstract level, the typology shown in Figure 25.7 may provide a more useful framework in relation to tactical management. It defines the impact a contingency plan can have on the plan when implemented, rather than its impact on the problem situation. The categories in this typology are similar to those identified by Aubry et al. (1998) for planning heuristics.

5 The Control Process

The control process used by the farmers is shown in Figure 25.8 (Gray 2001). Other studies (Gladwin and Butler 1984; Gladwin et al. 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998; Gray et al. 2003) have also shown that farmers monitor a range of indicators and compare these to intermediate objectives or targets in their plans. When an indicator reaches a threshold value, a decision point is identified. Decision rules are then used to determine what action to take. This may be to continue the implementation of the plan, or it may be to modify the plan in some way. At each decision point in the plan, farmers had a set of sub- or contingency plans. Decision rules are used to select the contingency plan that would best minimize the impact of any deviation from the plan.

The control process used by farmers is also similar to that advocated in the normative literature (Barnard and Nix 1979; Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994; Parker 1999). The recording and storage of monitored information is assumed in most models of control (Barnard and Nix 1979; Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994), although Dalton (1982) viewed it as a separate function of management. Much of the data collected by farmers is not recorded. This is not surprising given the quantity of information and the subjective, qualitative nature of much of it. Gray (2001) reported that limited analysis was undertaken on the data collected by the farmers in his study, and where this did occur, it comprised mainly of the calculation of means or ratios as proposed by Barnard and Nix (1979). Information, stored in memory or in some documented form (e.g., a farm diary), was later used for other management functions such as contingency plan selection, diagnoses, evaluation, and planning as proposed by Boehlje and Eidman (1984).

Mauldon (1979) stated that control encompasses the decision of whether or not to depart from the current plan. This was a key part of farmers’ control processes, and as with the normative
model, they compared the monitored information to their targets (or standards). If the performance indicators were below (or above) the targets, then farmers continued to monitor the implementation of the plan, much in the same way as proposed in the normative literature. However, when one of the performance indicators matched or exceeded a target, a decision point was reached to either continue to implement the plan or adopt a contingency for it. For both options, secondary indicators were used for option selection. Relative to the normative literature (Barnard and Nix 1979; Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994; Parker 1999), which focuses on identifying deviations and the need for management control, farmers put additional input into the use of targets to control implementation (Gray 2001).
Farmers use a diagnostic process to identify the reasons for a deviation from the plan, and an evaluation process to assess the efficacy of a management decision (Figure 25.8). An important distinction in this model is that two processes, diagnosis and evaluation, were identified. In the normative literature, these two processes are encompassed under a general term, “evaluation” (Barnard and Nix 1979; Mauldon 1979; Boehlje and Eidman 1984; Parker 1999). The results also support the views of Johnson (1954), Mauldon (1979), Makeham and Malcolm (1993), and Parker (1999) that learning is an important outcome of the evaluation process (Figure 25.8). Once the cause of a deviation from the plan was identified, farmers implement an appropriate control response (Figure 25.8). This was again consistent with the normative literature (Barnard and Nix 1979; Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994; Parker 1999).

5.1 Monitoring

A farmer’s monitoring process is comprised of the factors that were monitored, the method of monitoring, the roles the monitored information played, the means by which, and reasons why monitoring frequency changed, and dealing with errors. These aspects are discussed in more detail in the ensuing sections.

5.1.1 The Factors that are Monitored

Farmers monitor a large number of factors in relation to production management. For example, Gray (2001) identified that the farmers in his study monitored between twenty-eight and forty-one factors over the summer-autumn period. Landais and Deffontaines (1989) reported a similar breadth of monitoring. As seen in Figure 25.9, the factors monitored by the farmers in Gray’s (2001) study were both internal (those which the case farmers have control over) and external (those outside their control). This approach aligns with Kennedy (1974) and Boehlje and Eidman (1984) who suggested a systems approach for identifying factors to monitor and separate

![Figure 25.9 A Typology of the Factors Monitored by Farmers](Source: Gray 2001)
these on the basis of whether variables were endogenous or exogenous. Boehlje and Eidman (1984) recommended identifying areas of control on the basis of enterprises or activities. They separated these into production, servicing, and marketing enterprises but did not separate internal and external factors. As such, climate would be incorporated under production.

5.1.2 Monitoring Methods

As seen in Figure 25.10, Gray (2001) classified the monitoring methods used by farmers into a typology. The objective, subjective distinction was made by Parker (1999). Gray (2001) found that subjective methods could be further separated into quantitative and qualitative methods. A subjective, quantitative method was one where a quantitative value was placed on a subjective assessment of a factor, such as pasture, condition, and yield scoring. The converse applied to subjective qualitative measures such as the visual assessment of pasture on-hand or cow body condition where no numeric value was used.

Indirect measures have also been found to be important in farmers’ monitoring systems and these were sometimes used in preference to a direct measure (e.g., use of milk production to measure pasture cover over summer) (Gray 2001). The effective use of these indirect measures required an in-depth understanding of the cause-and-effect relationships within the production system.

Subjective, qualitative methods can be separated into two sub-categories: conscious and pre-attentive (Gray 2001). The former applies where farmers consciously made a visual assessment of a factor of interest. The latter applies where a factor was monitored subconsciously. The state of the factor (e.g., cow condition) was not registered consciously by the case farmers unless they were either asked about it, or it crossed some threshold. For example, a farmer began to monitor his herd more intensively when average body condition score fell below a desired level. Most measures used by farmers in Gray’s (2001) study were subjective. They were considered to

![Figure 25.10 A Typology of the Monitoring Methods Used by Farmers](Source: Gray 2001)
be timely, rapid, and required no capital outlay. They also had acceptable accuracy because they were calibrated against accurate objective measures. Parker (1999) argued that farmers were more likely to adopt subjective indicators, provided their accuracy was established through calibration to standards, because they were convenient and faster to measure. He also suggested that a proportion of farmers replaced objective measures with subjective measures once they had learned the association between relevant indicators. Thus, farmers learn visual “cues” that are associated with system performance. These then replace the objective measures. Another advantage of subjective measures was that they provide multivariate information whereas the information provided by objective measures tends to be univariate (Paine 1997).

5.1.3 The Role of Information from the Monitoring Process

Monitored information played several important roles in relation to farmers’ tactical management (as seen in Figure 25.11). These were planning, decision point recognition, triangulation, early warning prediction, control response selection, and learning (diagnosis and evaluation). Gray (2001) observed that, prior to the start of each planning period, farmers used their monitoring systems to collect information about the farm state for planning purposes.

![Figure 25.11 A Typology of the Roles Monitored Information Played in the Tactical Management Process Used by Farmers](source: Gray 2001)
The use of monitoring information for decision point recognition may be for one of three purposes: to recognize when to implement the next activity in the plan, to recognize that there is a significant deviation from the plan (problem recognition), or to recognize an opportunity. The majority of the indicators used for decision point recognition could be classified as lead indicators as defined by Parker (1999) after Kaplan and Norton (1996a,b,c), that is, they indicate progress towards the achievement of the plan.

The third role played by the monitored information was triangulation where it was used to ensure the veracity of the monitoring system. This prevented reliance on a single measure that may have been incorrect, a problem identified by Osburn and Schneeberger (1983). It also allowed subjective measures to be calibrated correctly against objective measures such as milk production or average pasture cover. Four methods of triangulation were used by the case farmers in Gray’s (2001) study. In effect, the case farmers had created a monitoring “network” that ensures information is timely, accurate, and inexpensive. This “network” has been created through a detailed knowledge of their production systems, confirming Kennedy’s (1974) and Wright’s (1985) views that the development of an effective control system is dependent on a farmer having a detailed understanding of his or her system.

In Figure 25.11, we see that the fourth role played by the farmers’ monitored information was a form of early warning prediction (Gray 2001). Harsh et al. (1981) also discussed the role of information in making predictions to identify problems in advance: a critical aspect for coping with climatic uncertainty.

Information was also used for control response selection (Gray 2001). Once a decision point had been identified through a primary indicator, secondary indicators were used to determine whether to implement the next activity in the plan, or a control response. If it was the latter, the secondary indicators in conjunction with heuristics were then used to select the most appropriate control response. Boehlje and Eidman (1984) mentioned the role of heuristics in the selection of control responses.

Finally, as shown in Figure 25.11, information monitoring was used for learning. Diagnosis was used where the cause of a deviation from the plan was unknown, whereas evaluation was used to assess the outcome of some aspect of the plan. Evaluation is recognized as an important function in the management process (Barnard and Nix 1979; Mauldon 1979; Boehlje and Eidman 1984; Parker 1999), but only Harsh et al. (1981) explicitly discussed the role of diagnostic information in identifying the cause of a problem and identifying opportunities for improvement in farm performance.

5.1.4 Activation, Termination, and Frequency of Monitoring

The farmers in Gray’s (2001) study had developed heuristics to determine the activation, termination, and frequency of monitoring. Most factors were monitored at a subconscious or “pre-attentive level” on a daily basis as they went about their normal farm operations, similar to those described by Gladwin and Murtaugh (1980). Four factors were found to activate (or terminate) the conscious monitoring of a factor as suggested in Figure 25.12. Threshold values that activated (or terminated) monitoring of a factor were either direct or indirect measures of the factor. A threshold was either an absolute value, or a “rate of change” in the factor.

The farmers in the 2001 study monitored most factors on a daily basis using subjective, qualitative methods. Other factors (e.g., herd and pregnancy testing) were monitored infrequently (one to three times) over the summer–autumn. Intermediate monitoring intervals (two to fourteen days) were used for the more formal methods (subjective, quantitative, or objective). However,
5.2 Decision Point Recognition

The most important role played by the information collected through farmers’ monitoring systems was its use to determine decision points during the implementation of the plan. Gladwin and Butler (1984) reported that the first decision point used by a decision maker is whether or not to implement the plan. The next decision point occurs at any point in the plan where more than one sub-plan can be embedded and a choice has to be made. This is similar to the definition
Gray (2001) uses where he defines a decision point: “any point in the implementation phase where farmers must decide between the implementation of: (i) the next activity in current plan, (ii) a control response, or (iii) an opportunity”. As such, there were three types of decision point recognition processes: implementation point recognition, problem recognition, and opportunity recognition (See Figure 25.14).

When a primary indicator met or exceeded a target, it was the secondary, not primary, indicators that were used by the case farmers to identify a problem. A problem existed if the secondary indicators showed that conditions at the time differed from those predicted in the plan. Similar results were reported by Gladwin and Butler (1984), who found that a farmer’s choice between implementing the plan and introducing a contingency plan was dependent on the conditions at the time of the decision.

### 5.3 Diagnosis

Diagnosis was undertaken by farmers in situations where the actual outcome differed significantly from their expected outcome. Although several authors (Mauldon 1979; Barnard and Nix 1979; Boehlje and Eidman 1984) in the normative literature mention the need to identify the reasons for a deviation from the plan, few explicitly refer to this process as diagnosis. Diagnosis is more commonly recognized in decision-making models where it is normally termed as problem detection or a definition (Kay 1981; Boehlje and Eidman 1984; Kay and Edwards 1994). In one of the few descriptive studies, albeit on strategic decision making, Ohlmer et al. (1998), reported that farmers undertook problem detection. However, little detail was provided about the nature of the farmers’ problem detection processes in this publication.

The process the farmers in Gray's (2001) study used to determine when to undertake a diagnosis is shown in Figure 25.15. A plan was developed which contained “planned” milestones and associated outcomes. The plan was then implemented and the “actual” milestones, and associated outcomes (a function of the environment and case farmers’ implementation and control processes) were monitored. Monitored information on the state of the farming system and the environment were used, along with the case farmers’ system models, to predict “expected” milestones and associated outcomes. These expectations were updated as new information became available. Deviations from the plan were identified when the measured milestones or outcomes differed significantly from those predicted in the plan. If no deviation was identified, then the implementation of the plan continued. However, if a significant deviation was identified, the case farmers then determined whether the deviation was significantly different from their expectations. If it
was not, then a suitable control response was selected. However, if it was, then this deviation, not the deviation from the plan, initiated the diagnostic process.

Mauldon (1979) and Barnard and Nix (1979) discuss the need to identify the cause of a deviation between actual and planned performance. However, no mention is made of the role of expectations in this process. This is an important finding because it is only when an expectation is not met, rather than a planned level of performance, that determines when diagnosis is undertaken. This explains why the case farmers undertook limited diagnosis during the study despite experiencing considerable climatic variation. The process of using system models to predict expectations from information collected through the monitoring system meant that the case farmers knew the outcome (or next milestone) and the reason why it had deviated from the plan before it occurred. As such, there was no need for diagnosis. However, where the case

---

**Figure 25.15** The Process Used by the Case Farmers to Determine When to Undertake a Diagnosis

*Source: Gray 2001*
farmers’ expectations were not met, diagnosis was promptly undertaken to identify the cause of the inaccurate prediction. Ohlmer et al. (1998) also reported that farmers either knew the cause of a deviation from the plan or, if they did not, diagnosis was undertaken. No mention was made of diagnoses in earlier studies of farmers’ tactical management (e.g., Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998).

Several reasons have been identified as to why the farmers’ fail to predict a milestone or outcome (Gray 2001). The first was that their system models are not well enough developed to accurately predict outcomes under certain conditions. This occurs where environmental conditions are outside a farmers’ experience or when new inputs or management practices are used. A second reason is that the monitoring system is providing inaccurate information upon which the predictions are based. This often occurred under unusual environmental conditions and again reflected a limitation in the case farmers’ system models. The final reason was that the plan was not implemented as expected. This occurred when someone other than the case farmer implemented the plan incorrectly.

Because diagnosis was found to be about expectations not being met rather than planned outcomes, the reasons for a deviation as mentioned above are quite different from those proposed to account for a deviation from the plan. For example, Barnard and Nix (1979) identified four reasons why the actual outcome might deviate from the plan. These were that the underlying assumptions in the plan were wrong, the targets were not achievable, or changes in either the socio-economic or biophysical environment had occurred. These are problems to do with planning or changes in the environment. In this study, the reasons for a deviation from expectations were due to problems associated with system knowledge, accuracy of the monitoring system, and implementation. The planning problems mentioned by Barnard and Nix (1979) could be considered a sub-set of problems related to incomplete or incorrect system knowledge.

The above results support Scoullar’s (1975) view that managers perform two types of decision-making processes, those for routine decisions, and those for novel decisions. This is similar to Simon’s (1960) programmed and unprogrammed decisions and Gorry and Morton’s (1971) structured and unstructured decisions. Scoullar (1975) believed that a problem, as opposed to a routine decision, was a gap between actual and desired knowledge, not between actual and desired performance. For the case farmers, this is the nature of the problems they diagnosed. It is the knowledge, not the performance gap, that they are interested in closing when they initiate diagnosis.

The diagnostic process used by the case farmers is shown in Figure 25.16. If an outcome differed significantly from expectations, then the case farmers drew on their system knowledge to hypothesize possible causes. If their system models were inadequate for this process, they consulted with their peers or a local expert and then developed their hypotheses. The most likely true hypothesis was then selected and the means by which it could be tested, devised. Data was retrieved from either the case farmers’ memory or their recording system to test the hypothesis. If it was confirmed, the process was complete, but if it was refuted, the process was repeated with the next most likely hypothesis. Descriptive studies that report the use of diagnoses by farmers (e.g., Ohlmer et al. 1998) provide no information about the process applied. Similarly, in the normative literature, Lee and Chastain (1960) describe a three-step model that comprises of recognizing alternative problem definitions, analyzing alternative problem definitions, and defining the problem. However, they provide little insight into how each step is undertaken.

### 5.4 Limits to Control and the Environment

The inherent uncertainty within a manager’s environment is an important determinant of the limits to control (Ashby 1961). Therefore, any study of farmers’ management practices should
Yes

H1
H2
H3
- - Hn

Is system knowledge adequate?

No

Discuss possibilities with experts and/or peers

Generate possible hypotheses

Select most likely hypothesis

Devise suitable test for hypothesis

Retrieve data to test hypothesis

Test hypothesis

Hypothesis refuted

Test the next most likely hypothesis

Hypothesis confirmed

Hypothesis true if

A = X
B = Y
C = Z

Values for

A = 2.2
B = 4.5
C = 3.3

Do the values for

A = X?
B = Y?
C = Z?

Yes

No

Source: Gray 2001

Figure 25.16 The Diagnostic Process Used by Farmers
provide some description of the nature of the environment in which they operate. Production risk dominated other sources of risk (seen in Figure 25.17) over the summer-autumn period. The supply of their main source of feed, pasture, was climate-driven, and the farmers felt they had limited ability to “control” this. Wright (1985) and Mathieu (1989) both identified climate as a major source of variation on farms. Although the case farmers set precise production objectives for budgeting purposes, they did not expect to achieve these objectives due to climatic conditions. This is in line with Wright’s (1985) and Kaine’s (1993) views that where managers have insufficient system variety to offset the variety in the environment, they will set broad, imprecise objectives.

### 5.5 Control Responses

Any deviations from Gray’s (2001) case farmers’ plans would be accounted for by five key reasons:

(i) The underlying assumptions in the farmers’ plans were incorrect.
(ii) Targets in the plan were not achievable.
(iii) Changes in the biophysical environment had occurred.
(iv) The monitoring system was inaccurate.
(v) The plan was implemented incorrectly.

Three of these reasons (i–iii) were also proposed by Barnard and Nix (1979). They also identified changes in the socio-economic environment as a reason for deviations from the plan. However, this aspect did not influence the case farmers’ plans, and this is in part a reflection of the production management focus of the study. The results could have been quite different if the research focus had been finance or marketing. The primary cause of deviations from the plan was the weather.

The Gray (2001) case farmers used three of the four types of control responses defined in the literature (Mauldon 1979; Dalton 1982; Boehlje and Eidman 1984) to cope with the variation in the environment. These were preliminary, concurrent, and historical control. They did not use an “elimination of disturbances” control response. However, these results are a function of case selection because some New Zealand dairy farms use irrigation of pastures for this purpose. Concurrent control was the predominant type of control used by the case farmers as would be

![Figure 25.17 Sources of Risk Faced by Farmers](source: Gray 2001)
expected for tactical management. Preliminary control was used to prevent the occurrence of animal health problems such as bloat and facial eczema and forage crops and silage were fed during periods when pasture growth rates were most variable. Historical control was used as Mauldon (1979) proposed, after learning had taken place.

The most common form of concurrent control was plan modification. Modification of the monitoring system, viewed as a form of historical control by Boehlje and Eidman (1984) was used concurrently to ensure the accuracy of the case farmers’ monitoring system.

The control responses used by farmers can also be considered from a risk management perspective (Jolly 1983). Risk management responses used by farmers can be classified as those that mitigate risk impacts and maintain short-run flexibility. Martin and McLeay (1998) reported that over 70% of the pastoral farmers in their survey used short-run flexibility to manage risk. Both maintaining flexibility and having feed reserves have ranked in the top four risk responses in many studies (Shadbolt et al. 2013; Boggess et al. 1985; Patrick et al. 1985; Wilson et al. 1993; Martin 1994; 1996).

As proposed by Boehlje and Eidman (1984), the final step in the control process was the specification of the control response. The control response selection process in Gray (2001) is similar to that reported in several tactical management studies (Gladwin and Butler 1984; Mathieu 1989; Cerf et al. 1993; Fleury et al. 1996; Aubry et al. 1998). These studies reported that at each decision point, farmers had a set of sub-plans or (“regulations”) and used heuristics to select the most appropriate sub-plan for the conditions at the time.

6 Implications for Practitioners

This chapter provides a model of the tactical management process against which practitioners can compare their own management practices and reflect on areas for improvement. Detailed knowledge of the production system and environment were identified as critical for effective tactical management in the field of production. As such, this area is important for farmer education. An important distinction is made between planning aids and the cognition behind planning. It is the latter that is much more important in the development of effective plans despite limited research being undertaken in this area by the discipline. The chapter has also highlighted the importance farmers place on control relative to planning, again an area that has tended to receive limited attention in the literature.

The chapter identifies important areas of a farmer’s production management that should be evaluated. For example, in relation to planning, they could consider their choice of a “typical” plan, the heuristics underlying the plan structure in terms of sequencing, timing, input and target selection rules, the contingency plans they have to cope with variation, and their choice of intermediate and terminating targets. Similarly, under control, they could consider the effectiveness of their monitoring system, what they monitor, how they monitor, and the frequency of monitoring, the means by which they select control responses and identify opportunities. The management process also has an important role in relation to learning and therefore is central to improving farmers’ management skills and productivity.

7 Conclusion

Management can be thought of as a cyclic process involving irregular planning decisions followed by regular, repetitive, and less major implementation and control decisions. The interdependence of planning and control is central to management. Under conditions of high uncertainty, farmers placed greater effort on control than planning. To facilitate control, plans incorporated targets,
contingency plans, and contingency plan selection rules. Decision rules, monitoring, and learning processes played an important role in coping with a changing and unpredictable environment.

As expected, the majority of tactical decisions undertaken by farmers are of a structured nature. Instances of unstructured decisions were identified and these were in situations where a knowledge gap existed. Such unstructured decisions required the use of diagnostic, evaluation, and learning processes. Because of this, farmers tend to spend limited time on planning, using a “typical” plan based on experience. Plan structure rather than planning per se is the focus at the tactical level. The effectiveness of a farmer’s plan is a function of the heuristics used to develop the plan, highlighting the importance of the cognitive aspect of planning.

A small proportion of New Zealand farmers use formal planning techniques or “planning aids”, and they may alternate between these and informal heuristic-based techniques throughout the year. However, the majority of farmers are using heuristic-based techniques. Although farmers normally draw on a “typical” plan each year, strategic decisions, learning (or historical control), atypical tactical decisions made in the previous planning period, and the state of the farm at the start of the planning period, in combination with heuristics and mental simulation, can result in the modification of a tactical plan in any one year.

The control process is important for plan implementation, control selection, and opportunity finding. Farmers tend to use a complex and holistic monitoring process. That is, they monitor a wide range of factors to obtain a more complete picture of the state of their farms. This could include pasture mass, clover content, sward color, the clumpiness of the sward, animal behavior, rumen fill, and body condition. In contrast, extension agents would recommend simpler monitoring systems such as measuring pasture mass and weighing stock. “Expert” farmers use their intimate knowledge of the production system to develop low-cost, timely, and accurate monitoring systems. Critical to the successful implementation of a farmers’ plan is the range of contingency plans they have to manage both upside and downside risk along with decision rules and priority rankings that help them select the most suitable contingency for the situation. The final conclusion in relation to this chapter is that empirical research into the tactical management processes of farmers is critical for the development of theory and management techniques that are relevant to practitioners.

References and Bibliography


Johnson, G. L. (1954) “Managerial concepts for agriculturalists: Their development, present status, importance, shortcomings, and usefulness,” *Bulletin 619*. Lexington: Kentucky Agricultural Experiment Station, University of Kentucky.


