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FINE TUNING THE FARM PLAN: SOME REAL WORLD EXAMPLES OF PUTTING POLICY INTO PRACTICE

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Introduction

The farm plan has been a primary tool for delivering on-farm soil and water management for the last 50 years. Up until the creation of Regional Councils and the introduction of the Resource Management Act (RMA) in the early 1990's, farm plans focussed on erosion control to protect soil resources and support river management. Since the 1990's the scope and format of farm plans has varied over time and across regions, to accommodate sustainable land management, biodiversity and riparian management objectives, in accordance with regional priorities and evolving policy development.

The current focus of farm plans is on the control and mitigation of nitrogen (N) and phosphorous (P) loss from farming activity, and the incorporation of nutrient management tools such as the OVERSEER® model. A number of farm plan formats are in use, ranging from the Land Environment Plan (LEP - Beef + Lamb NZ Inc.) which represents a national standard, to a range of variants built to serve regional policy objectives and Regional Plan rules. However, fundamental management issues of the farm plan prevail in regard to soil erosion, waterway protection and management such as stock control.

Over the last twenty years issues arising from farm nutrient discharge to waterways has driven a substantial body of research in New Zealand, and considerable effort goes into producing policy and rules for protecting or improving regional surface water quality. An assorted and extensive toolbox of management tools has been produced and continues to be developed. Application of the toolbox in the variability of real world situations requires elements of translation, and what ultimately results on the farm is likely to be a pragmatic combination of policy and tools, site conditions, advisory know-how and prevailing farm management.

Turning policy into practice

The Farm Plan continues to serve as a primary mechanism for delivery of Regional Policy at farm scale. The contemporary farm plan addresses nutrient budgeting and fertiliser management, critical source areas (CSAs) for potential P discharge and best-practice waterway management. For regional council staff and consultants delivering farm plan advice the challenge is to build a property-based programme that will satisfy policy and comply with Regional rules as required, while proving the landowner with practical and meaningful options. Measureable outputs sought are specific management practices, on-ground works and workable timeframes.

It should be noted that a farm plan is not just a set of prescribed actions, it is also an opportunity to lead management behaviour change. However, the landowner is already managing an enterprise with multiple seasonal and daily tasks, with limitations on time and funding and a prevailing level of uncertainty. Seeking change to management practice requires some appreciation of behavioural change and can borrow from adaptive, developmental approaches such as Nudge theory, or an integrated strategies approach like an Encourage-Enable-Engage-Exemplify model (HM Government, 2005).

Plan structure with scope for landowner amendment and innovation that fosters programme ownership is justified, and field interpretation may apply to ensure the intent of policy is maintained. Farm plans which are adaptive and progressive, prioritising actions and offering future pathways, provide best fit for uptake of management change.

At the outset of the planning process it is necessary to establish a basis for the property programme, explaining policy and its driving factors, while drawing on national trends, regional precedents and leading examples of early adapters, to cultivate landowner acceptance and engagement. This is most effectively achieved through a face–to-face relationship with landowner to build confidence, achieve buy-in and facilitate collaborative decision making. Programme development can then proceed through assessment of issues and selection of compatible solutions, drafting a schedule of workable actions, provision of additional recommendations and supporting information resources, and consideration of monitoring or maintenance factors arising from the programme. Field-based assessment is key part of this process, and if done in close communication with the landowner provides a valuable learning opportunity for the recognition nutrient management issues and choice of management action. For the farm planner, familiarisation with the property is essential for understanding property management and building the relationship with the landowner.

N management in the contemporary farm plan is mainly focussed on inputs, through nutrient budgeting and fertiliser practice, coupled with effluent or irrigation management where relevant. A similar approach is used for P management, but also includes particular P (sediment) discharges and integrates directly with the fundamental soil and water management components of the farm plan. While nutrient budgeting is generally addressed ‘at the kitchen table’, and/or in consultation with the landowners fertiliser advisor, field inspection is required to assess CSA’s, waterway issues and erosion risks, and select appropriate management options.

Field Assessment and Management Options

Broadly, CSA assessment is based around surface drainage pattern, soil disturbance levels and soil characteristics. Waterway evaluation focusses on sediment/particular P discharge risk related to waterway connectivity, farm management and best fit solutions for specific site conditions. As a potential sediment source erosion issues are also addressed, as existing and potential erosion, based on land unit (geology, soil and slope combinations) susceptibility. Erosion type and severity is generally categorised in accordance with Land Use Capability (LUC) standards. Identification and evaluation of CSAs and related sediment sources is a primary objective of field inspection, and is generally prioritised as follows:

1. Cropping areas
2. Tracks & crossings
3. Feedpads (‘un-managed’ e.g. in-situ silage stack feeding)
4. Stockyards
5. Troughs & gateways
6. Rubbish pits and offal holes
7. Other soil disturbance in surface flow paths, e.g. stock camps

Management options for CSAs are well documented and include practice guides such as the NIWA Attenuation Toolbox (McKergow *et al*, 2007). Waterway assessment includes channels with permanent flow and incised seasonal channels, with an emphasis on livestock impacts or channel erosion issues. Open or tile drain discharge points are also considered. Management options include part (sheep grazing only) or full stock exclusion and riparian planting. Drain discharges may be treated with small constructed wetlands, in accordance with NIWA guidelines (Tanner, Sukias and Yates, 2010). Erosion management techniques are extensively documented, and are summarised in the Soil Conservation Technical Handbook (Hicks and Anthony, 2001).

An overview of field assessment key factors and management options is provided in Table 1 below. Management actions include both primary measures (basic management), and additional actions to enhance the effect of those measures. In cropping paddocks for example, field assessment focusses of surface flow path pattern, particular where paths exit the paddock and convergence of paths upslope of the exit point. This defines sites for use of a temporary grass filter strip (GFS) where surface flows concentrate before leaving the paddock and subsequently connect with major waterways. The GFS is used in conjunction with a strategic grazing pattern, progressively moving down slope to terminate at the GFS, in accordance with management practice developed for grazing of winter crops (Orchiston, Monaghan and Laurenson, 2013).

Table 1. Key assessment factors and management options

Source	**Key Assessment Factors**	**Basic Management**	**Additional Actions**
CSAs			
Cropping Areas	Surface flow paths, converge, exit paddock	Temporary GFS Strategic grazing pattern	Cultivation on contour or no till; fertiliser timing and type for (low P retention) soil
Tracks & Crossings	Proximity to waterways, inclined crossing approaches	Diversion of surface flows	Filter zones, soak hole sediment traps
Feedpads & Stockyards	Surface flow paths, proximity to waterways	Diversion of upslope runoff, effluent collection / management	Yard drainage to filter zones, sediment traps or constructed wetlands
Troughs & gateways	Surface flow paths, proximity to waterways	Grass filter zones	Linings (bark or wood chip), surface flow diversions
Rubbish & Offal pits	Proximity to waterways and depth of water table	Compliance – setback from streams and water tables	Progressive rehabilitation, diversion of upslope runoff
Erosion	Land units (LUC), Structures in waterways	Planting, erosion control structures	Ground cover/stock management, retirement
Waterways & drains Permanent streams, gully forms with intermittent flow, surface and subsurface drains	Livestock impacts – treading steep side slopes, pugging gully floors	Full or partial stock exclusion, sheep-only grazing	Filter zones, planting (exotic or native), wetland construction or enhancement

Additional actions can enhance basic management and include no-till cultivation, timing of P fertiliser application to avoid storm events, use of low solubility P fertilise on low P retention soils and treatment of tile drain discharge if these are present. Generally these management options are relatively low cost for the farmer but do require alteration of management practice. By providing basic management actions and a choice of additional options, the landowner can learn and adapt progressively.

Farm tracks represent areas that are regularly disturbed and generally lack adequate ground cover, and when set out across the gradient of natural terrain will also act as interception/diversion flow paths for storm runoff, particularly where compacted wheel ruts form. Lack of surface cover in conjunction with concentration of runoff flow results in organic matter and sediment mobilisation, which commonly discharges to waterways at track crossing points. This discharge can contribute nutrients to waterways and may also cause damage to track surfaces or erosion of crossing embankments (Fig. 1). To limit build-up of concentrated flow on tracks or to divert flow off crossing approaches, 'cut-off drains' (low profile diversion bunds across tracks, formed to be trafficable) can be readily installed (Fig. 2). This practice is widespread in forestry road construction and is documented in a number of Regional Council and industry guidelines. Construction of track cut-off drains is familiar to many earthworks contractors, but is also compatible with farm equipment, or hand tools on some sites, and can be undertaken by farm staff.

Fig.1 Track runoff point and erosion on culvert embankment, no runoff. controls in place.

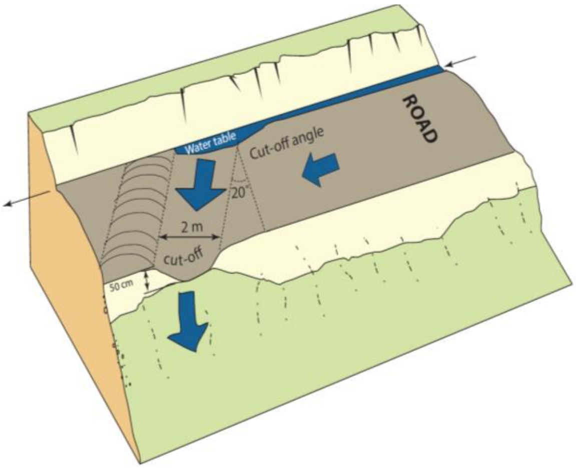

Fig. 2 Schematic of a water 'cut-off' for track drainage (Source: [www.marlborough.govt.nz)](http://www.marlborough.govt.nz)

Purpose-built feedpads should incorporate effluent management measures, but small-scale improvised feed pads e.g. in-situ silage stack feeding are unlikely to be managed as such (Fig. 3). These situations need to be assessed in terms of site drainage (presence of shallow gravels or coarse sands) and surface flow paths with potential to connect with waterways. Interventions include not feeding in situ on excessively drained sites, and diversion of flow paths to stable, grassed areas.

Stockyards may warrant similar treatment, but assessment of upslope areas that may be contributing surface flows across stockyard areas should also be carried out. Where possible, diversion bunds or drains can be installed to prevent upslope runoff from 'flushing' the surface of stockyards (Fig.4), and help to prevent yards from becoming muddy/pugged when required for stock handling during wet periods.

Fig.3 In-situ feedpad on limestone base, surface flow paths require assessment and diversion management.

Fig.4 Diversion drain to direct upslope runoff away from yards

Diverted surface flows from the above areas or tracks can be treated with grass filter zones or small-scale constructed wetlands. Grass filter options are extensively documented and a key factor in encouraging drop-out of sediment in surface flows is to reduce the velocity of those flows. This is largely influenced by the slope of the receiving area, and grass filter zones should be selected to be as near to 0% gradient as possible. Wetlands are an effective option for reducing N loss, but have limited ability to effectively and consistently removed P (Sukias and Tanner, 2011). For nutrient management, wetlands rely on a body of suitable vegetation and associated litter, rather than open water. Design and construction advice is accessible through a number of Crown Research Institute and Regional Council sources. Landowners may have sites which are readily adapted, such as disused/decommissioned farm dams, which will reduce construction cost.

Stock treading pads that form around troughs can have elevated concentrations of soil P compared with adjacent pasture, and similar but less elevated concentrations can be found around gateways (Lucci, 2011). Trough pads in close proximity are flow path-linked to drains or streams represent particularly high risk of P loss to waterways (Fig. 5). Management options include set back of troughs from waterway margins (minimum 20 m), assessment and diversion of surface flow paths connecting trough pads and gateways to waterways, or laying of wood/bark chip linings (as used for stand-off pads) on heavily trodden areas. Lack of trough maintenance such as leaks or stuck values (Fig. 6) leading to saturation of (high P) trough pads will compound the risk of P loss.

Fig. 5 Trough pad flow path to track drain, and culvert intake at bottom right of photo; landowner elected to move trough to low risk site nearby.

Fig. 6 Saturated trough pad 12 m from ephemeral flow path; basic maintenance will reduce risk of P loss and save water.

Field assessment should also address broader scale treading impacts, in particular pugging on (seasonally) wet paddocks, or treading damage to turf and topsoil layers on riparian margins and sidlings in intermittent water courses. Well established tools are available for aid management of pugging/soil compaction issues, including the Visual Soil Assessment (VSA) kit, or the production impacts approach of the AgResearch TREAD model which predicts pasture yield decline in relation to levels of soil compaction. The basic options for management of treading impacts on waterway margins include full or part (cattle and deer) stock exclusion, with fencing to suit required stock control and topography of site. For filtering of surface flows traversing the riparian margin, resident grasses offer a nil cost option for the landowner, but are likely to require carefully managed grazing periodically and removal of deposited sediment over time.

Other minor CSA's, such as stock camps (bare soil) in storm water surface flow paths, can be assessed as found during field inspection, and rated for risk in relation to proximity to waterways. Management options might include pruning of overhanging tree branches to reduce shading, and oversowing sites with heavy rates of grass seed, e.g. 30 kg/ha of rye grass, plus clover or other species to suit. Field assessment should also review rubbish pits and offal holes, which should be set back from waterways as regulated by Regional Council Plans. In addition, best practice management options include progressive rehabilitation (covering with topsoil and re-grassing), diversion drainage if necessary to prevent surface water flows discharging to the pit, and alternative disposal for items like fertiliser bags

With full stock exclusion from riparian margins, numerous options for planting with exotic or native tree and shrub species for stabilisation and stream shading are available, and are extensively documented in a range of industry and Regional Council publications. Cost is a dominant consideration for the landowner and ranges from around $800/ha for poplar/willow pole planting or $1,200/ha to $2,500/ha for various woodlot plantings, up to $20,000/ha to $40,000 (or more) for native planting. Riparian planting practice generally focusses on a range of colonising shrubby species and cost variation is largely driven by plant density per ha at establishment. This is illustrated in Table 2 where three planting densities are compared with standard unit costs, with allowance for extra releasing or possible brushweed re-infestation at wider spacings.
Substantial cost savings are to be had between high density (10,000 plants/ha) and medium to low density (2500 – 4500 plants/ha) plantings. Higher densities of 10,000/ha or more are often advocated for advanced canopy closure as a weed control (plant competition) strategy, but the costings clearly demonstrate that with weed management otherwise applied to lower density plantings considerable savings are attainable for landowners, releasing more financial resource for principal riparian management such as fence construction or water supply.

Table 2. Cost comparison per ha of three native planting densities

Stocking Rate	Plants/ha		**10,000**	**4,500**	**2,500**
Canopy closure	Years		2 - 3	3 - 4	4 - 5
Plant cost (PB3)		$3.50	$35,000	$15,750	$8,750
Establishment Cost		$2.00	$20,000	$9,000	$5,000
Releasing	x2	$0.35	$7,000	$3,150	$1,750
	x1	$0.45		$2,025	$1,125
	x1	$0.60			$1,500
Brushweed (hr)		$50.00		$100	$200
Total per ha			**$62,000**	**$30,025**	**$18,325**

Discount native plant supply schemes also offer cost saving opportunities for landowners. However the impact of plant spacing still prevails, even when there is a relatively small difference in planting density. This is illustrated in Table 3 where discounted plants are used for the higher density (4500 plants/ha), while the lower density model uses non-discount stock and incurs further cost for additional releasing, but delivers a cost saving of 20% overall.

Table 3. Comparison of discount and non-discount plant stock at slightly different spacings

Stocking Rate	Plants/ha		**4,444**	**3,086**
Spacing	m		1.5 x 1.5	1.8 x 1.8
Plant cost (PB3)		$3.00	$13,332	
		$3.50		$10,801
Establishment Cost		$2.00	$8,888	$6,172
Releasing	x3	$0.35	$4,666	$3,240
	x1	$0.45		$1,389
Total per ha			**$26,886**	**$21,602**

A collaborative research project undertaken by Environment Bay of Plenty and Scion (Stace, Bergin and Kimberly, 2003) identified a group of 10 commonly used riparian revegetation species capable of achieving near canopy closure at 4 – 5 years at relatively wide spacings of 2 m x 2 m, and the results suggested an optimum spacing of around 1.8 m x 1.8 m for such species. While high density planting models may be advocated on the basis of early canopy closure, lower density models, inclusive of additional costs for weed control if required, provide a much greater level of affordability for landowners and funding agencies alike.

Other planting options such as willow poles should use non-invasive male clone cultivars specifically selected for stream planting (e.g. *Salix matsudana* x *alba* ‘Moutere’), along with pruning management for tree form and pasture shade reduction. Potential woodlot sites should be selected for ease of access and minimal environmental risk at harvest. Harvesting activity is controlled by Regional Plan rules, and should aim to minimise ground disturbance and manage slash to avoid stream impacts.

On-farm soil erosion, generally triggered by major storm events, is a significant source of sediment discharge to waterways. Existing erosion features are readily identified in the field, and from aerial photography to some extent. Management should consider *potential* erosion and identification of susceptible land units, using LUC methodology supported by regional Land Resource Inventory information. Regional Council staff can assist landowners with such assessment and generally provide advice and facilitate materials supply for erosion control plantings or structures. As ratepayers, landowners should be encouraged to take full advantage of these services

The field assessment process should also be alert to potential erosion issues represented by on-farm earthworks, including crossing embankments (Fig.7), farm dams in waterways (Fig. 8), land contouring or reclamation works, and major cut or fill slopes associated with tracking and fence line benching in hill country. Management interventions will generally focus on appropriate drainage controls and surface stabilisation. For structures in waterways in particular, key design features such as culvert pipe size or provision of an adequate spillway for high flows should be assessed, and such structures should also be compliant with Regional plan requirements.

Fig. 7 Erosion of crossing embankment by overtopping flow; culvert pipe requires design size check and a high flow Spillway should be installed.

Fig. 8 Gully head erosion at poorly stabilised farm dam outlet; extensive repair is required, including a suitably designed flume.

While the combined management effect of addressing all above factors will generally limit discharge of sediment and particulate P from point or diffuse sources, there may be situations such as cropping areas or convergence of track networks for example, where measures such as flow diversions or GFS's are insufficient to cope with peak volumes of sediment runoff. In these situations the use of a constructed sediment trap might be considered, although for on-farm application conventional design for (construction site) sediment retention ponds is secondary to selective methodology for adaption to specific site conditions.

Fig. 9 Farm dam with high level of sediment deposition: actions include managing sediment at source, removal of sediment and potential modification of dam with baffles and filtered outlet.

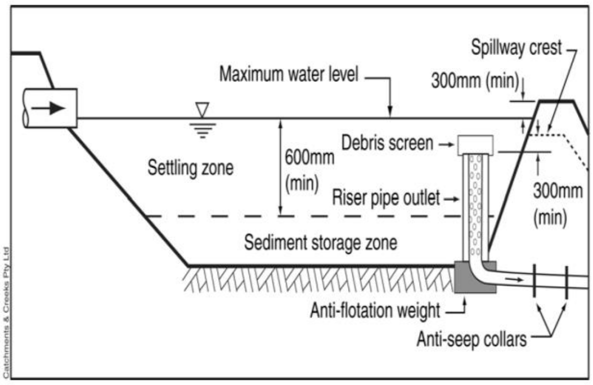

Fig. 10 Sediment retention pond with perforated upstand outlet (Source: IECA, 2008)

To avoid high construction cost, existing structures such as disused farm dams may be modified with a suitable outlet structure to promote the deposition and dewatering of a body of sediment. Such situations may readily be apparent where farm dams have become highly silted (Fig. 9). While the preferred width-to-length ratio of a sediment retention pond is 1:3, in irregular shaped ponds baffles made of netting fence and windbreak cloth can be used to lengthen the flow path between the pond inlet and outlet. Sediment ponds require periodic maintenance to remove sediment and retain a settling zone depth (Fig.10), and also provide monitoring and research opportunities that may attract construction and maintenance support from third parties.

Conclusion

The primary intention of the field inspection process is to identify potential sediment and particulate P loss situations, to provide awareness and nutrient management knowledge for landowners, and thence a basis for joint decision making on a set of appropriate management actions and priorities. The farm plan can then be structured around CSA, erosion and waterway issues, with key management actions set out alongside additional recommendations to promote choice and landowner decision making. This approach helps to offset the resistance that can be encountered by directive farm plan approaches largely designed meet external objectives and processes.

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