REGRASSING SILT
TECHNICAL DOCUMENT FOR RURAL PROFESSIONALS

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Flood sediment comes in varying textures ranging from heavy to light i.e. from clay to silty loams to sand. The clay loams are normally flat and feel smooth and silky and are usually found in ponding areas some distance from the river. The clay loams retain water for some time and if deep can't be cultivated for considerable time because machinery will bog. Silt to silty sands are often ruffled in surface texture and slightly gritty to touch. In this medium silt the surface dries fairly quickly but the subsurface remains moist. Sand is often rolling, gritty to touch and drains very rapidly, can contain a lot of gravel and is usually adjacent to the river. Sand and silt often intermingle in layers in flood sediment.

As a river floods, the coarser sand material is deposited in the higher reaches of a river and closer to the river bank and these will be of poorer quality – less fertile and less suitable for pasture growth. Further down a river and further away from the river more clay loams are deposited and in theory, contain higher nutrient levels. But the fertility of the clay and silt loams will be highly variable and should be tested. Analysis of flood sediment flowing under the Palmerston North bridge showed that the resulting soils that will form from this flood will be highly fertile once weathering has occurred. The nutrient level is such that it can be assessed at containing around 30% topsoil and 70% mudstone sediment.

Current fertility of the flood sediment. The silt washed on to the land can either be fertile material from a neighbour's farm upstream, or it could be subsoil washed from slips on steeper land. In any case it will contain very little or no organic matter, will probably have very low nitrogen (N) content, and also be low in phosphate. Its pH level could also be different from that of existing pasture.

Soil tests can be taken in wet silt as the sample is dried in the laboratory. However remember that when the soil is wet less soil is collected per sample so more samples will be required. Sampling may be more challenging than normal.

Soil test information collected to date

Location	River	Type silt	pH	Ca	Olsen P	K	S(SO4)	Mg	Na	ASC
Palmerston North	Manawatu	Clay/silt loam	6.9	9	9	3	12	24	5	8
Palmerston North	Manawatu	Sandy	6.7	5	5	2	15	15	4	3

Flood sediment will need potassium and phosphate fertilisers and nitrogen
Pure silt should not have in excess of 300 kg superphosphate because the low ASC limits the ability of the soil to capture the fertiliser. Smaller more regular fertiliser applications will be necessary or slow release fertilisers may also be an option in soils that are predominantly flood sediment.

Pasture damage
Pastures that have been under water for 2-3 days will probably recover, but those under water for a week or more in warm summer conditions will be dead. If a pasture hasn't shown signs of recovery after a week then consider it to be dead.

The longer the flooding lasts then the more damage to submerged pastures. Recently-grazed pasture plants are more prone to silt and flooding than those with some regrowth on them. Pastures with leaf tips above water will

survive, and subtropical grasses like paspalum will survive better than the temperate grasses most commonly grown on New Zealand farms.

Some pasture plant species are more sensitive to this damage than others. The grasses best suited to withstand deep siltation are grasses with rhizomatous spreading habits – couch and browntop. Creeping buttercup also tends to survive longer. Perennial ryegrass will only survive about a week, cocksfoot a few days longer, and tall fescue and timothy longer yet. Anecdotal evidence also suggests that Timothy and Fescue do well on sandy silts in local accretion areas.

Flooding effects on pastures are worst when:

- Flooding occurs when soil temperatures are warm.
- A pasture has been hard grazed.
- Flooding is prolonged.
- Pastures are covered by at least 5 mm of silt.

Damage to cereal crops

Factors affecting pastures also apply to cereal crops. Continuous surface flooding affects these crops more severely than sub-surface inundation.

Intermittent or continuous flooding, for periods even as short as three days, can seriously reduce grain yields in wheat, oats and barley. The plants suffer from poorer root growth and penetration, reduced heading and delayed ear emergence, delayed plant maturity and reduced grain size. A week of flooding will affect all cereals. Applying 100 kg nitrogen per ha can overcome the grain reduction in intermittently flooded cereals.

Damage to maize

Once maize has reached the silking stage shallow depths of temporary flooding where the plant remains upright will not usually cause significant immediate damage. After 7-8 days under water it is expected that the maize will be substantially affected with a lot of root damage especially if the soil is sealed off with silt. The options for disposal of maize that is not suitable for harvest are:

- Harvesting to air and spread on paddock and then eventual cultivation
- Use giant discs to cut up maize and mix with silt at same time.
- Harvesting at cob height to make silage.

Some may be contemplating burning the maize but if it is heavily contaminated with silt it is not likely to burn easily.

Is the silt smelling?

In waterlogged soils, anaerobic respiration by soil organisms produces ethylene gas, which also reduces plant growth and root extension. This is most obvious in barley and less so in wheat. There is also a greater danger of shallow-rooted plants, such as perennial ryegrass, being uprooted and pulled out by grazing stock. Naturally, pastures that have been recently flooded are more prone to pugging by livestock.

When river silts become smelly this indicates that toxins are present as a result of anaerobic organism activity. It is probable that seed germination after sowing directly on smelly silt will be impeded by these toxins. However recovery of the anaerobic silt following cultivation will be rapid. It is recommended that anaerobic silt be cultivated and not oversown or direct drilled without area.

Plan recovery

The farmers need to understand the feed requirements for the upcoming winter and following spring and summer and plan pasture recoveries accordingly. There is little point to putting the entire flooded farm into temporary pastures to find that an identical feed pinch exists in the following spring when the pastures have to be renewed again. Assess each paddock for time under water, density of live pasture remaining after 10 days, silt type (sandy, clay/silt loam) and depth (<5 cm, 5-10, 10-20, >25 cm). Using the damage information and feed requirements in the future plan the recovery designing the appropriate mix of short term and permanent pastures. Then a time line for regrassing needs to be established. Some paddocks will need immediate action while others will need to dry before cultivation. Back up plans are needed if the contractor cannot be sourced when desired.

The depth of silt

The regressing response will differ depending on the depth of silt. Shallow silt (<5 cm) could be ignored, up to 10-25 cm silt can be cultivated and greater than 25 cm will either need to be oversown or partially cultivated and forage planted directly in the silt.

Less than 5 cm. If there is less than 5 cm of silt and the grass has been under the water for less than 3 days then it is probable that the existing grass will come through the crust. Existing grass recovers much more quickly than sown grass. If there are open parts in the pasture then these can be undersown using perennial grass:clover mixes. If a feed pinch in winter and spring is anticipated as a result of the flooding then as a special case open pastures can be drilled with rapidly establishing ryegrasses, such as hybrid ryegrass or Italian types, and these will also supply good quality feed over the coming winter months.

In pastures that have been killed but have little silt contractors have been doing 1 pass with a chisel plough, followed by a rotor tiller and then pastures have been drilled.

Apply nitrogen fertiliser (N) at about 50 kg N/ha to assist recovery, either as urea (110kg/ha), as ammonium sulphate (at 200kg/ha), or as DAP (at 275 kg/ha). Avoid using more than 25 kg N/ha down the spout if sowing seed with a drill.

5 to 10 cm of silt: If silt has completely covered the pasture it will not survive and it will need to be regrassed. Normal cultivation methods will apply at these depths. Cultivation is recommended because silt is relatively infertile, will contain no organic matter or N, and have poor structure making it prone to pugging. A barrier to water drainage may occur on the interface between the old pasture and silt. It is better in the long run to cultivate these depths of silt so silt and topsoil are combined. However, if the silt is very sandy it may be more appropriate to remove the sand first if this is possible. In heavy and medium silt there will be a time lag while the silt dries out sufficiently to be cultivated.

The resowing should be successful as it is normal farm practice in moist areas of lower North Island is to resow pastures in early autumn March-early April. When sowing the whole paddock it best to decide whether to sow short-term species, or perennials, as it is not always wise to mix them. Short-term Italian and hybrid ryegrasses will be preferred where feed production this winter is crucial, or where weeds/fertility are expected to make it difficult to establish a good perennial pasture mix this year.

Apply around 300kg/ha superphosphate or 150kg/ha Cropmaster 20 (no more than 30 kg N/ha) at or near sowing. Adjust the rate according to soil test information (if you have it). Apply a further dressing of N (20-40 kg N/ha, up to 100 kg urea) four or so weeks following seed germination. A second N application in a further 4-6 weeks may also be needed, as there will be little or no N cycling in the silt.

10 to 25 cm of silt: In silt of this depth there will deeper and shallower parts in the paddock. By levelling the paddock it may be possible to bring most of the paddock into cultivatable depth. Once the silt has dried and heavy machinery can be used then deep ploughing (e.g. swamp plough) will help to mix the silt with the topsoil. If this is successful then cultivate and sow as normal. If the resulting soil is predominantly silt rather than topsoil then sow in either short-term ryegrasses or forage oats or other short term crops and return to permanent pasture the following spring or autumn.

Deep silt >25cm. Try and build up the organic matter of deep silt. Stocking of newly sown areas should begin as soon as the soil can support the stock treading without damage. Supplementary feed could be fed on these areas to increase organic matter cycling.

Revegetating sand/shingle will be difficult. If grazing is required within 2 years then the sand/shingle needs to removed and stacked in a big stockpile. It can then be used for races or sold. Alternatively the area can be retired and sown in blue lupins (stock edible variety). But care will need to be taken to prevent it seeding as it may be difficult to control later. Other river bank reclamation vegetation may also be appropriate.

There are two options for deep clay/silt loam flood sediment and this is either oversowing with a helicopter or cultivating the silt and drilling. In the latter case be patient and wait for the silt to dry sufficient to use machinery. Use light weight tractor and lightly break up surface, drill forage oats (good option from farmer experience) or short-term ryegrass and harrow behind. Anecdotal evidence reports success with brassicas on silts including in Pasja-clover mixes in the following spring. Red clover (be aware of oestrogen issue) is also reported to do well in the following spring/summer period. Chicory/red clover mixes are also a possibility but there is no data documenting their performance on silt.

Oversow pasture seed from the air. Oversowing is not an option for sandy silt. In clay/silt loams oversowing is an option. Oversowing needs to occur when the silt is still damp and sticky and must occur quickly once water has receded. Once the silt has caked and cracked it is too late for oversowing. Relying on rewetting the silt after rain to foster germination of oversown seed is not likely to work. It is risky and there is a fine time-line for success.

Oversowing is a more risky sowing method than cultivation or direct drilling, so use higher than normal seed rates. If the silt is too wet, the seed may rot, and if it is too dry then the surface of the silt will cake and crack and the ryegrass seedlings will struggle to grow primary roots into the "new" soil. Once silt is dry seed may also blow away and birds become a major problem because they can land on the dry silt.

Use coated good quality seed to increase its chance of establishing and improve ballistics. Bare seed is highly likely to fail. If clover is included in the mix, then make sure it is inoculated (at only very little extra cost) and contains molybdenum. Experimental results have shown short-term ryegrasses to be the most effective in generating feed from oversown silt in winter and spring.

The structure of flood silt is poor – it packs down hard and this may affect the long-term persistence of the new pasture and subsequent winter grazings. There may also be many weed seeds in the silt, making spraying necessary, or paddocks may need to be resown next autumn with a permanent seeds mix. The lack of organic matter is the main requirement of these new silted soils. Stocking of newly sown areas should begin as soon as the soil can support the stock treading without damage. Supplementary feed could be fed on these areas to increase organic matter cycling.

Cereal Forages: In theory cereal forages are an ideal crop to help deep silt to recover, they are tolerant of low fertility and respond very well to nitrogen applications. Their deep rooting means they can exploit nutrients and water deeper in the soil profile and the large root mass helps to hold erosion prone soils in place and aid soil structure. However little data is available on their success following silt inundation and what is available is fairly negative. Following oversowing they failed to establish in an experiment because of birds eating the seed. Farmers report that Japanese millet and oats performed well in silt.

Below is information sourced from Canterbury which may be relevant.

There are several cereal forage options to consider.

Ryecorn is very easy to establish and has a huge rooting volume making it very suitable for improving soil structure and preventing erosion. It provides multiple light grazings over the winter and early spring and can be harvested for seed in the summer. It is not very suitable for cereal silage. Forage quality is high for first grazing but tends to decline rapidly in subsequent grazings.

Triticale is a cross between Ryecorn and wheat and has a good blend of traits from both parent plants. Triticale has good establishment and disease resistance from Ryecorn but has higher palatability and production from its wheat parentage. Triticale is generally the highest producing cereal forage and is very versatile since there are single and multi-graze cultivars available. The multi-graze cultivars can be utilised for winter feed and then harvested as silage in the spring.

Oats are easy and reliable to establish and therefore less risky in the harsh silt environment. But they do not provide the same options/ versatility as Triticale. In order to achieve a successful grazing/ silage system, it would be paramount to graze once, early and lightly in the winter to avoid damage to the crop; this should allow adequate regrowth to occur during spring for cereal silage production. However farmers may choose to mulch the crop rather than make silage.

Establishment Practices: Cereals are suitable for Spring or Autumn sowing, Spring sowings are best as soon as the paddock can be worked in spring to early October. Autumn sowings are best carried out between mid February and Early April. Autumn sowing of cereals is reliable in high rainfall regions with even spread. Earlier sowings will provide better establishment and higher DM bulk going into winter, allowing earlier grazing with higher DM masses.
Cereal forages are suitable for oversowing or direct drilling; in most cases direct drilling will give better results than oversowing especially if birds can't be controlled. Cereal forages are commonly sown at around 100 kg/ha, this will vary on the species, cultivar and thousand seed weight.

Fertiliser: Cereal forages will respond very well to fertiliser, phosphorus fertiliser mixes (e.g. Crop 15 or 20) should be used before or during sowing at around 250 kg/ha. Large gains will be achieved even in low fertility soils through frequent (2-3) dressing of Nitrogenous fertilisers at 50-100kgN/ha.

Soil Structure: The fastest way to improve soil structure and fertility may be a compromise between animal production and plant DM production.
Animals will benefit from high quality forage and high rates of utilisation, whereas the soil may benefit more from high DM mass and DM percentage crops being mulched in rather than being passed as animal effluent.

Grazing Management: Ideally a multi-graze system would provide higher DM production to utilise and subsequent organic matter returned to the soil. The grazing system will reflect the objectives mentioned above in terms of animal vs soil performance. Animal performance will be enhanced through the use of break fencing (incl back fencing) this will allow high rates of utilization and controlled animal allowance. Back fencing will aid plant recovery and persistence for further production. The most suitable time for grazing is any time between late tillering and boot stage. The best yield and quality combination occurs at the late vegetative phase. Early, moderate grazing can result in greater regrowth.

Silage Production: To ensure optimum silage production, grazing should be carefully managed to avoid plant loss or enhanced damage.Nitrogenous fertiliser applications will increase yield, Chemicals (herbicides, fungicides, insecticides and growth regulators) should be applied as recommended.
Harvesting is likely to occur around mid December from autumn sowings and Mid January for Spring sowing.

Experimental results

There are only two published reports on silt recovery and both deal with silt that is too deep to cultivate. The results from this experiment are briefly presented.

McKee JG and Graham G.J, 1952. Pasture establishment on flood areas of Gisborne flats. New Zealand Journal of Agriculture 84: 197-198.

Oversowing on three silt types (heavy, medium and light (sand)
Winter floods in Gisborne in 1948
Sowed in May 14 days after flood water receded or flood 2 July, 7 days after flood water receded .

Treatments:

1. Short rotation (20 kg/ha) and perennial ryegrass (20 kg/ha)
2. Short rotation ryegrass (16 kg/ha), perennial ryegrass (16 kg/ha), white clover (2 kg/ha), timothy (4.5 kg/ha), sub clover (2 kg/ha)

3,4,5 Same as 2 but at progressive 2 weekly intervals

6. Oats
7. Barley
8. Wheat
9. Same as 2 but clover inoculated.
10. All above with and without superphosphate (3/4 cwt per acre) and sulphate of ammonia.

Results:
Short rotation Italian ryegrass strikes better on heavy and medium silt than perennial ryegrass. The light silts (sand) had very poor strikes and are not suitable for oversowing. Perennial ryegrass and red clover also struck well but didn't produce much DM until the following spring and summer. Cocksfoot and timothy, white clover and sub clover struck poorly. Crops (wheat, barley etc) failed because birds ate the seed.

Strike and growth of grasses over winter were greatly improved by addition of superphosphate and sulphate of ammonia on medium and light silts but had little effect on the heavy more fertile silts (this would depend on fertility of which no information was given). Unfertilised sites had slow growth of winter but the difference disappeared in following spring and summer. On the light sandy silts oversowing was not worth while because they dry out fairly rapidly. In light sandy silts grading out and cultivation is recommended to bring some of the old topsoil to the surface. In heavy and medium silts oversowing is effective providing sowing down at the right time ie when water has subsided but the surface is still moist. Once the surface has been caked oversowing will fail owing to poor germination and heavy bird predation. Sowing while water is still on the surface will result in seed rotting. If it can't be done before drying then the area should be left until it is cultivable. Then it should be worked and sown in a crop to prepare it for sowing the next autumn. On areas covered too deep a deep-rooted crop should be sown.

The lack of organic matter is the main requirement of these new silted soils. Stocking of newly sown areas should begin as soon as the soil can support the stock treading without damage. Supplementary feed could be fed on these areas increase organic matter cycling.

Gray MH and C.J. Korte, 1990. Revegetation of river silt deposits. Fertiliser and lime report.

Cyclone Bola (March 1988). Where shallow sandy silt, heavy and medium silts of less than 10 cm little problems occurred because sediment dried quickly and could be cultivated and resown with pasture. Deep silty sediments (up to 1.5 m) derived from mudstone alluvium were more difficult to revegetate. The heavier silts had a high pH (7.9) and Olsen P's low but S were OK.

Plots were established one month after Bola (7 April) in a flood ponding area (1 m silt) while silt was still sticky and then again on 25 May when silt was dry on some plots. Treatments were untreated control and 18 combinations of 6 pasture species and 3 fertiliser rates (0, 150 and 300 kg DAP). Plots ungrazing during winter and spring.
Species
White clover 5 kg/ha innoculated
Strawberry clover 5 kg/ha innoculated
Lucerne 20 kg/ha pelleted seed
Moata 30 kg/ha
Matua praire grass 50 kg seed/ha
Drought master perennial ryegrass 30 kg/ha.

Results
All grasses established satisfactorily while legumes established sparsely from the April sowing. Lucerne grew well after germination but germination was sparse. The later seeding was ineffective because of birds and poor germination. In the first sowing the silt was too soft for birds to land. Sowing was not effective where water was still lying.
Nodulation was successful in legumes but strawberry clover struggled without fertiliser.

Fertiliser DAP kg/ha	0	150	300
15 July			
Moata	790	1300	1270
Droughtmaster	320	320	690
Matua	0	20	110
29 August			
Moata	2400	3230	2440
Droughtmaster	890	1050	1830
Matua	610	930	1200

***Information contributors**: This information has been compiled on behalf of MAF sustainable farming fund and Meat and Wool Innovation using information provided from experienced farmers, researchers from AgResearch, Massey University and Landcare and rural professionals from Greenfield's Communications, Dexcel, Wrightsons, Ravensdown, Hills Laboratories, E-Lab, Agriseeds, Agricom, Balance, QuinPhos, Pioneer, Hills Laboratory, Wilsons and Keeling, Horizons Regional Council, Pyne Gould Guiness, and Williams and Kettle.*

Potentially useful references on flooding and silt regeneration

Boswell, C.C.; 1979: Effects of flooding on pastures and crops – A review; Technical Report 6; March 1979
Boswell, C.C.; Flooding in pastures and crops – Plant tolerance and survival and effects on soil nutrients; Agricultural Science and Technology (MAF)
Farmer reports: Dairy Insight website.
Gray MH and C.J. Korte, 1990. Revegetation of river silt deposits. Fertiliser and lime report.
Harvey, Tim; Damage assessment codes – Massey University; 18/2/04
McKee JG and Graham G.J, 1952. Pasture establishment on flood areas of Gisborne flats. New Zealand Journal of Agriculture 84: 197-198.
Wrightston, 2004. Recovery after flooding. Wrightson website: Wrightson.co.nz/knowho

Resource material

Handout material for farmers is attached in PDF file
It is set up to print out in colour on A3
Printing out on A4, use scale to fit option on printer.
Will print out in black and white, though colour is better

A poster is available on request from Johanna (with at least three days notice) 06 351 8125. Cost approximately $60. Poster is provided as PDF file as well.