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Fertilizer-derived fluorine (F) in grazed pasture systems

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Introduction

- **P fertilizers (1- 4% F) are the major input of F to clover-based pasture.**
- **SSP @10–30 kg P/ha/yr adds 1–6 kg F/ha/yr**

Phosphate fertiliser	F (%)	P (%)
Sechura PR	3.4	13.1
Arad PR	4.0	14.1
Gafsa PR	4.1	13.4
North Carolina PR	3.5	13.0
SSP	1.08–1.84	9.0
TSP	1.3–2.4	21
DAP	1.2–3.0	20

PR - phosphate rock. Data from Loganathan et al. 2003.

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Introduction

- F concentration in top soils (0-100 mm depth) are projected to double in <100 yrs with regular P application to wheat and potatoes in South Australia

Crop	Input (g/ha)	Crop harvest (g/ha)	Net rate of addition (g/ha/yr)	Background soil conc. (mg/kg)	Years to double soil levels
Wheat	4000	3.0	3997	300	100
Potato	16000	10.0	15990	300	25

(McLaughlin et al. 1996). .

- Very little F is removed by plants and crops

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Introduction

- SSP applied at 30KgP/ha will double the F concentration in grazed pasture soils (0-100 mm depth) in <100 yrs

New Zealand	Input (g/ha)	Pasture uptake (g/ha)	Animal intake (g/ha)	Animal (g/ha)	Net rate of addition (g/ha/yr)	Background soil conc. (mg/kg)	Years to double soil conc.
Grazed pasture	6000	50	40	20	5880	300	51

(Loganathan et al. 2003)

- Very little F is removed by animals

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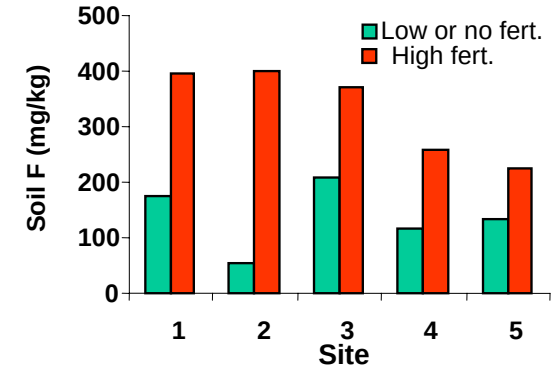
Survey of total F in heavily-fertilised and lightly-fertilised, or unfertilised, topsoils (0-75 mm depth)

(Loganathan et al. 2001, 2003)



Survey of total F confirms topsoil F has doubled in less than 70 years of fertiliser use

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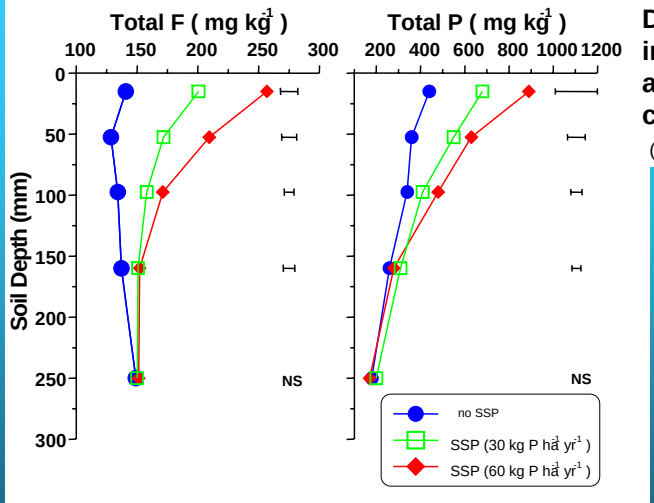

(Horizontal bars represent LSD values [5% significance].'NS' denotes treatment effects were not significant.)

Distribution of F and P in soil profile at site 5 after 10 yrs of continuous SSP use

(Loganathan et al. 2001)

F and P accumulation patterns are similar.
No significant downward F movement irrespective of rate.
85% remained within the top 120 mm depth.

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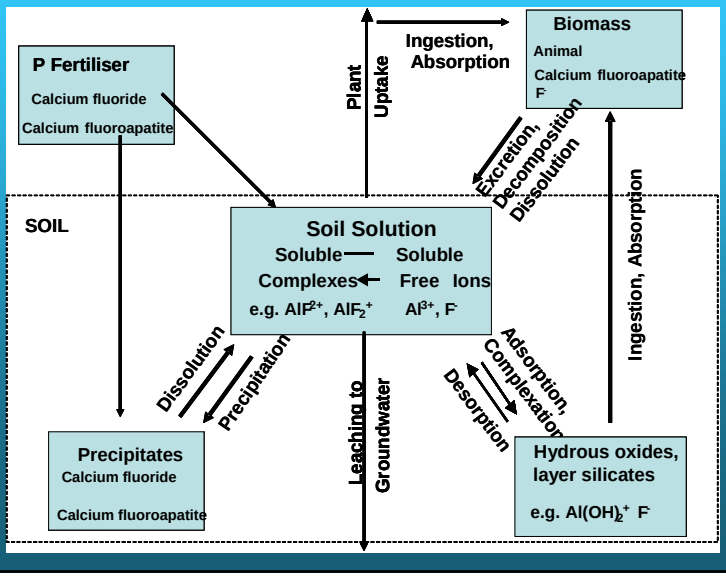
Fertiliser F accumulates in soils as sparingly soluble calcium fluoride and fluoroapatites or is adsorbed to hydrous oxides of Al. At low soil pH's it forms soluble complexes with Al .



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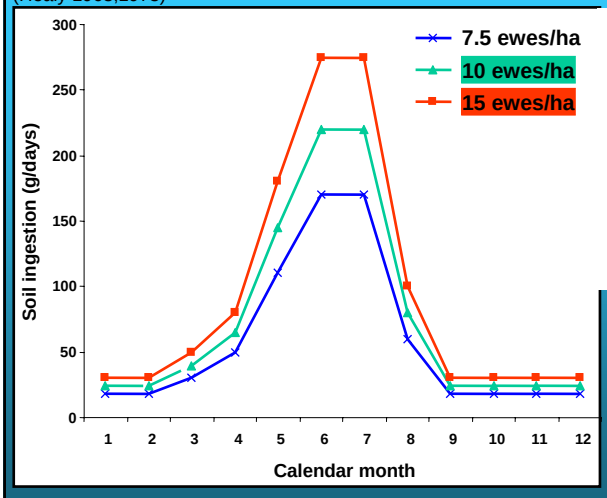
- **Grazing sheep and cattle ingest topsoil with pasture.**

(Healy 1968,1973)



Soil ingestion is high:

during winter (June, July, August). and

when stocking rate is high (low grazing and treading)

What happens to soil F when ingested ?

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Will soil ingestion cause Chronic fluorosis ?

A diet of > 60 mg available F/ Kg DM on a continuous basis leads to symptoms of Chronic fluorosis (Clark and Stewart 1983)

Lameness in cattle

Tooth wear in sheep

Risk of chronic fluorosis increases with increased topsoil F concentration, and rate and duration of soil ingestion

How much ingested soil F will be absorbed by the animal ?

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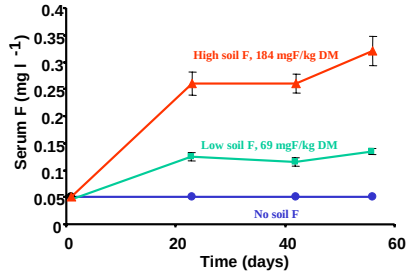
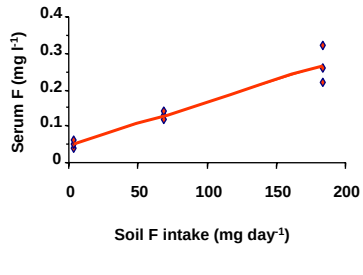
• Soil F feeding trial on sheep (Grace et al. 2003)

- **Three groups of sheep fed daily for 63 days with (1) Lucerne, (2) Lucerne + low F soil, (3) high F soil. Amount of soil = one winter's intake (100 g soil/day).**





Blood serum F conc.
(a) increased within 23 days (b) increased with soil F intake.

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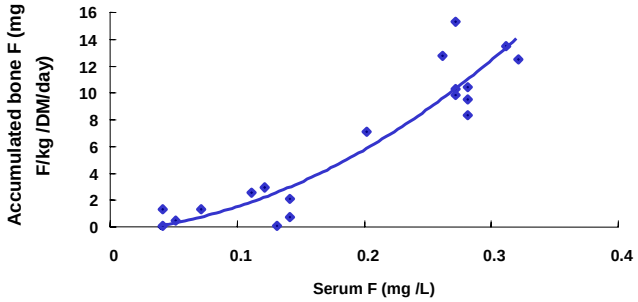
- **Bone F conc. increased after 63 days but they were below toxic level (2000–4000 mg/kg).**

Treatment	Basal Diet	Low F soil	High F soil
	mgF/kg bone		
Rib bone	739^{A}	797^{A}	1388^{B}
Radius bone	726^{A}	857^{A}	1271^{B}

(Grace et al. 2003)

Rate of bone F accumulation per day is related to serum F concentration.



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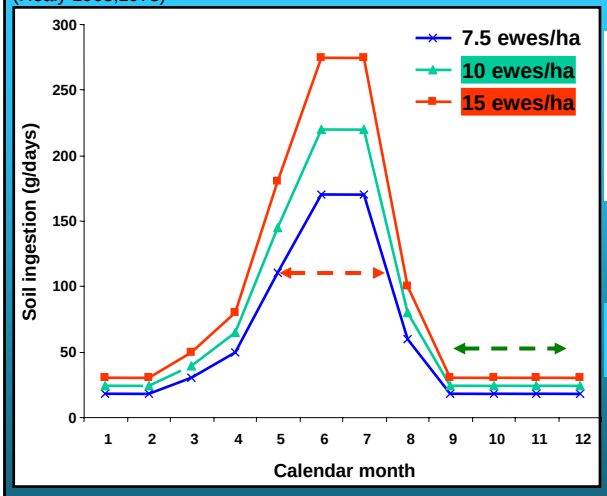
- **Grazing sheep and cattle ingest topsoil with pasture.**

(Healy 1968,1973)



After 2-3 months of high soil ingestion sheep graze spring pastures with low soil contamination.

What happens to serum and bone F?

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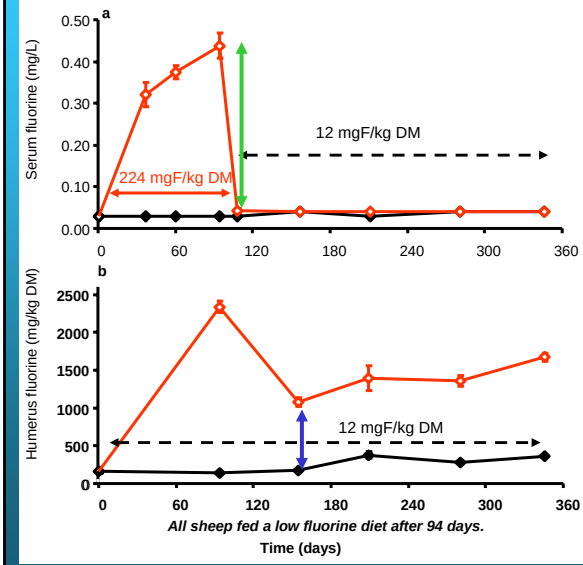
After 63 days of soil ingestion sheep graze spring pastures with low soil contamination. What happens to serum and bone F?

(Grace et al. 2007)



- Serum F responds rapidly to change in F intake
- Bone F reduces slowly and not all bone F is remobilised

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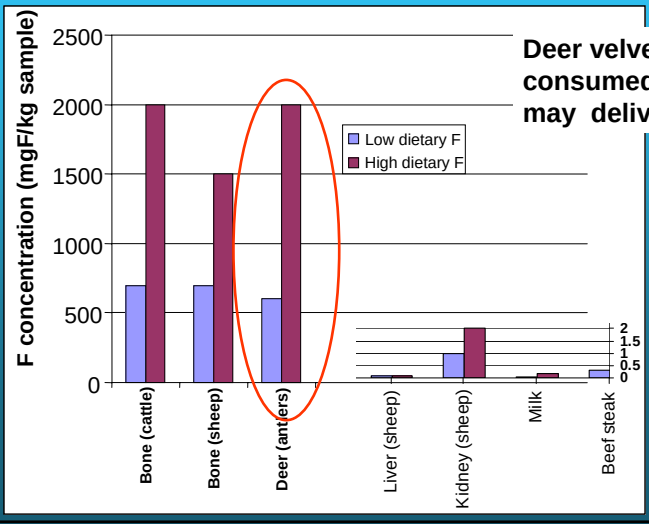
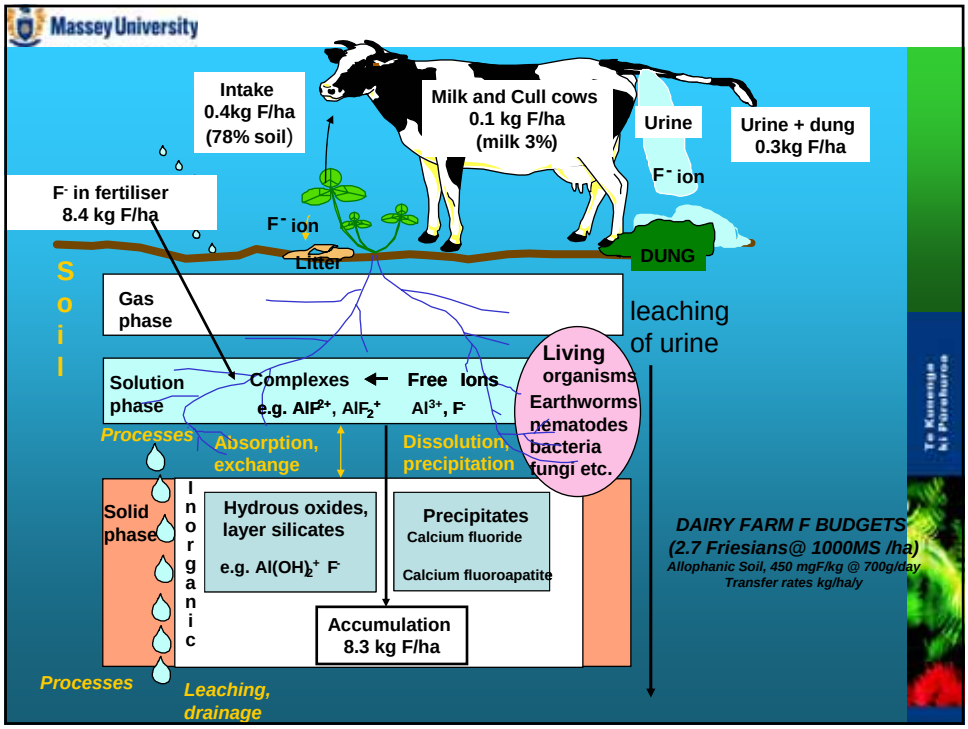
Intake of high dietary F (30 -109 mgF/kg DM) raises serum F

- leading to F sequestration in bone and antler
- but not in soft tissues and milk



Deer velvet products consumed @ > 2.5 g/day may deliver > 1mgF/day



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Conclusions

1. F added via P fertilizers mainly accumulates in sparingly soluble forms in the topsoil. Therefore F risk to ground water is low in most pasture soils.
2. Main pathway of F intake by grazing livestock is by soil ingestion which is high during winter.
3. F accumulates mainly in animal bones, not animal products such as meat and milk.
4. Current soil F concentrations are unlikely to cause bone damage in cattle and sheep if pasture covers are high.
5. Fertiliser derived F continues to accumulate in soils. Studies are required to investigate the cumulative effects of F accumulation in bones with increasing soil F levels and age of animals.

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