HOW RAINFALL ON A PLATEAU LEADS TO WATERLOGGING AND RUN OFF AT THE BASE OF SLOPE. STRONG SOIL STRUCTURE LEADS TO 2% RUN OFF @ 36mm/HR AS AGAINST SATURATED SOIL 60% RUN OFF

OW WATER FLOWS THROUGH HE SOIL LANDSCAPE

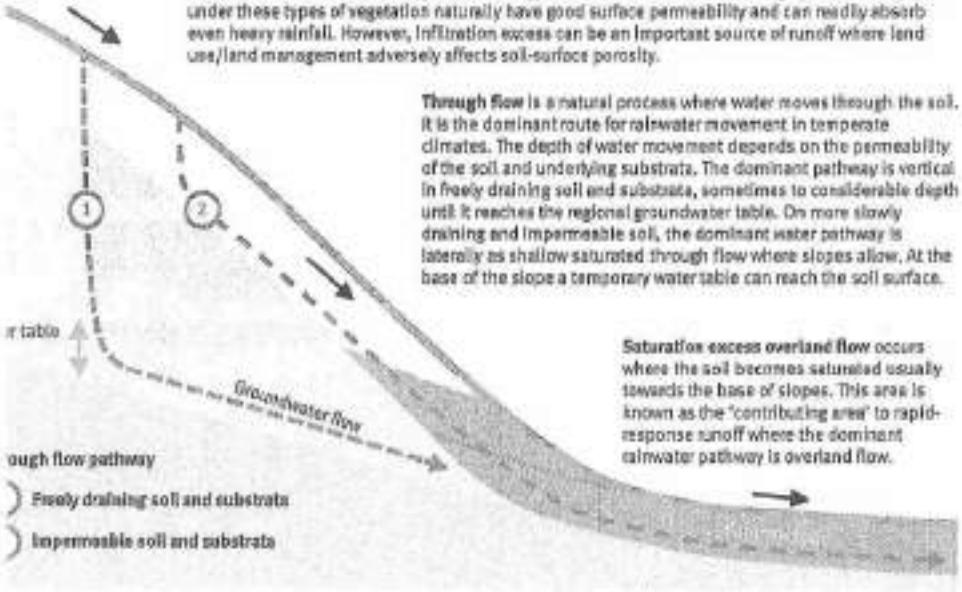
eration of runoff is a complex interaction between soil, geology, landform, vegetation and climate. The term 'runoff' s overland flow of water and also water that flows laterally downslope through the upper soil layers. Runoff causes the short crease in flow seen in catchments following rainfall. Surface water runoff or overland flow is where water flows across the face.

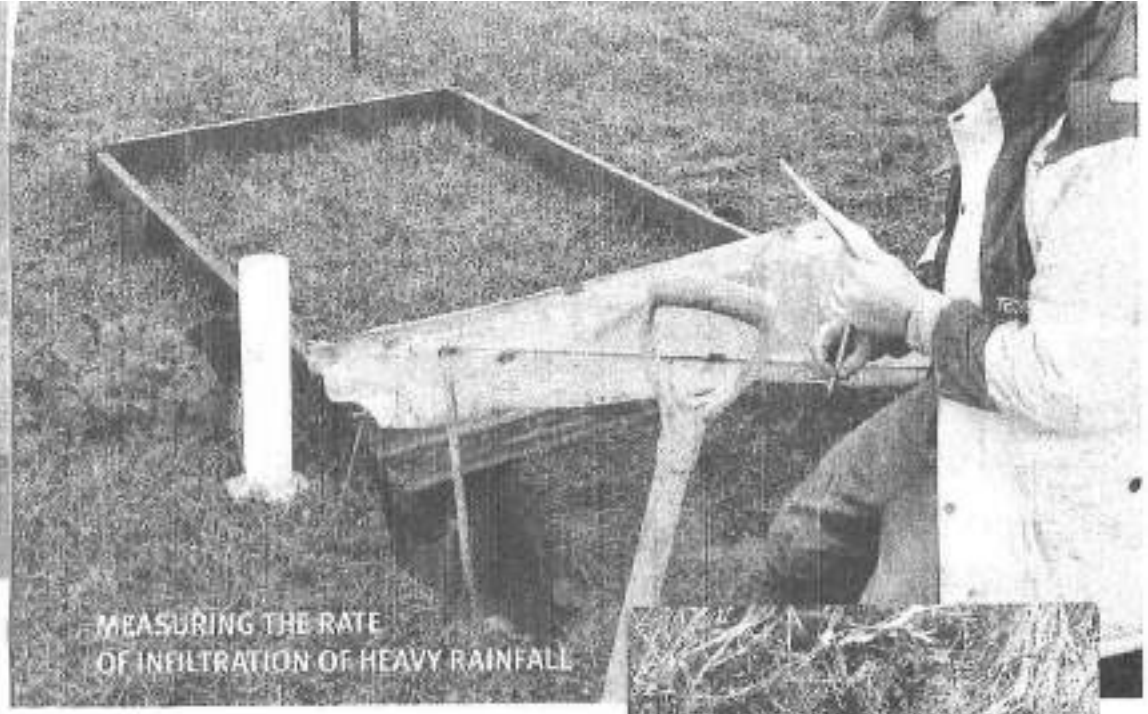
rocesses are widely used to describe the generation of runoff.

Infiltration excess occurs where rainfall intensity is greater than the infiltration capacity of the soil surface. Under thick natural vegetation this type of runoff is rare in the UK, largely because topsoils under these types of vegetation naturally have good surface permeability and can readily absorb even heavy rainfall. However, infiltration excess can be an important source of runoff where land use/land management adversely affects soil-surface porosity.

Through flow is a natural process where water moves through the soil. It is the dominant route for rainwater movement in temperate climates. The depth of water movement depends on the permeability of the soil and underlying substrata. The dominant pathway is vertical in freely draining soil and substrata, sometimes to considerable depth until it reaches the regional groundwater table. On more slowly draining and impermeable soil, the dominant water pathway is laterally as shallow saturated through flow where slopes allow. At the base of the slope a temporary water table can reach the soil surface.

Saturation excess overland flow occurs where the soil becomes saturated usually towards the base of slopes. This area is known as the 'contributing area' to rapid-response runoff where the dominant rainwater pathway is overland flow.





MEASURING THE RATE OF INFILTRATION OF HEAVY RAINFALL

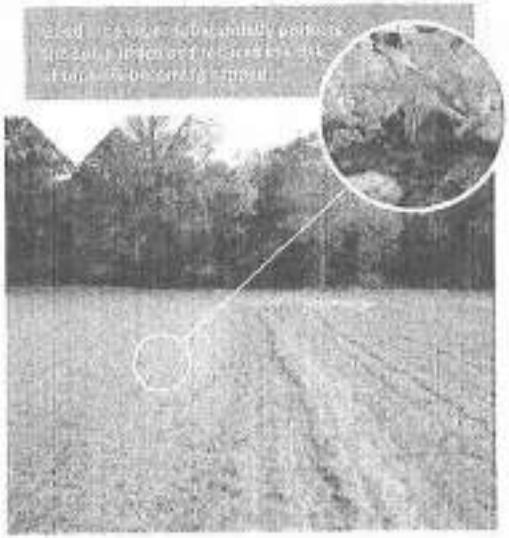
Experiments measuring the infiltration rate and runoff under heavy rainfall have been carried out on soils in Devon and Cornwall by the National Soil Resources Institute of Cranfield University. These experiments used a rainfall simulator to control the amount of rainfall coupled with a runoff trap.

At Boscastle, the study found that grassland with a strongly developed stable soil structure with fine granular soil aggregates only generated 2% runoff under 36mm/hr rainfall. Grassland with weakly developed soil structure with coarse, dense aggregates and low porosity had 60% runoff. This soil became saturated at the surface generating overland flow after 20 minutes of rainfall.

Similar results were found in experiments at Ottery St Mary where compacted grassland generated 88% runoff under 50mm/hr rainfall.

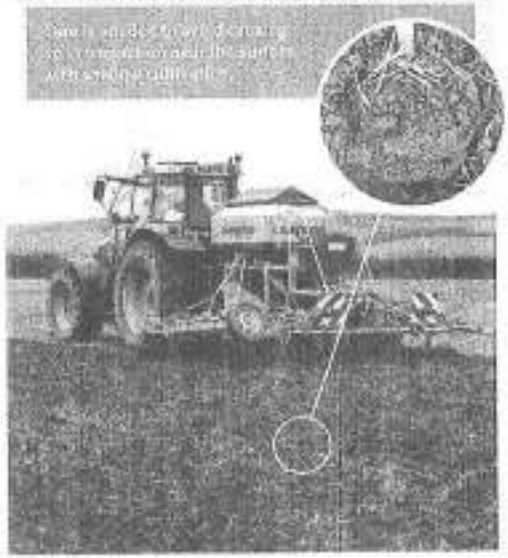
2 EARLY AUTUMN DRILLING OF CROPS

Good soil structure can be achieved and maintained by drilling in suitable soil conditions in the early autumn to ensure good crop cover before the onset of winter.



3 RETAINING CROP RESIDUES

Leaving crop residues on the soil surface can protect the soil from capping and can build up organic matter.

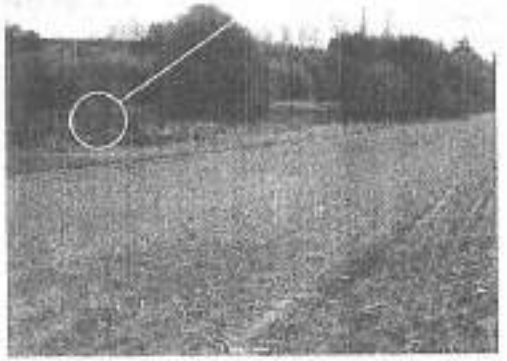


4 OUT-WINTERING OF STOCK

Fields used for out-wintering of stock should be relatively level and access points should be located to avoid channelling runoff. Grass runback areas should be used – a dry area where stock can retreat, lie down and avoid becoming too dirty and heavily damaging the soil.

5 WETLAND CREATION

There may be opportunities to create wetlands on alluvial soils to provide flood storage areas.



HIGH RISK OF CAPPING

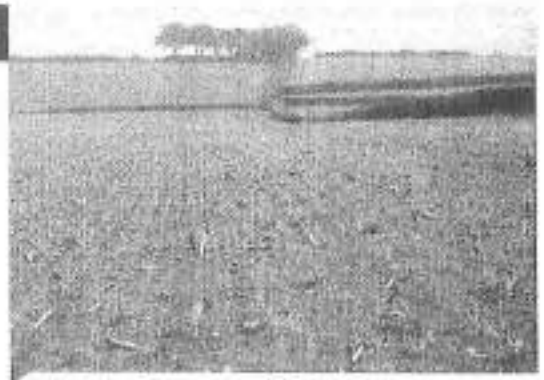
HIGH RISK OF SOIL COMPACTION

HIGH RISK OF CAPPING

Although sandy loam soils over the Sandstone have the potential to readily absorb rainfall, they can readily generate overland flow.

This occurs when bare soil surfaces become sealed by the battering action of heavy rainfall. Soil aggregates disperse during rainfall and pores become blocked with coarsely stratified clay, fine sand and silt forming a surface cap, which can be slowly permeable and greatly reduces infiltration rates.

Seedbeds formed in sandy loam soils are at risk of capping particularly when worked to a very fine tilth for precision seed placement. Soils with slightly higher clay content, typical of the Breccia, are more stable and less at risk of capping.



HOW GOOD PRACTICES CAN HELP PREVENT COMPACTION WHICH LEADS TO RUN OFF EG. PICS 1 + 2

HIGH RISK OF COMPACTION

Sandy loam soils have enough clay, silt and fine sand to make them vulnerable to compaction when they are moist.

Easily worked freely draining land on the Sandstone and Breccia attracts high value crops such as vegetables. These are often harvested late in the year and during winter which makes soils very vulnerable to compaction from heavy machinery.

Similarly cereal and grass seedbeds established late in the year on moist soils can become compacted.

Out-wintering stock on this land also has the risk of causing surface compaction and subsequent risk of surface runoff.

COMPACTION 1

OVERLAND FLOW OF WATER

Soils that are capped and/or compacted c
generate large quantities of overland flow
rainfall causing soil erosion, localised floo
pollution.

1mm of rain produces 10,000 litres of w
per hectare.

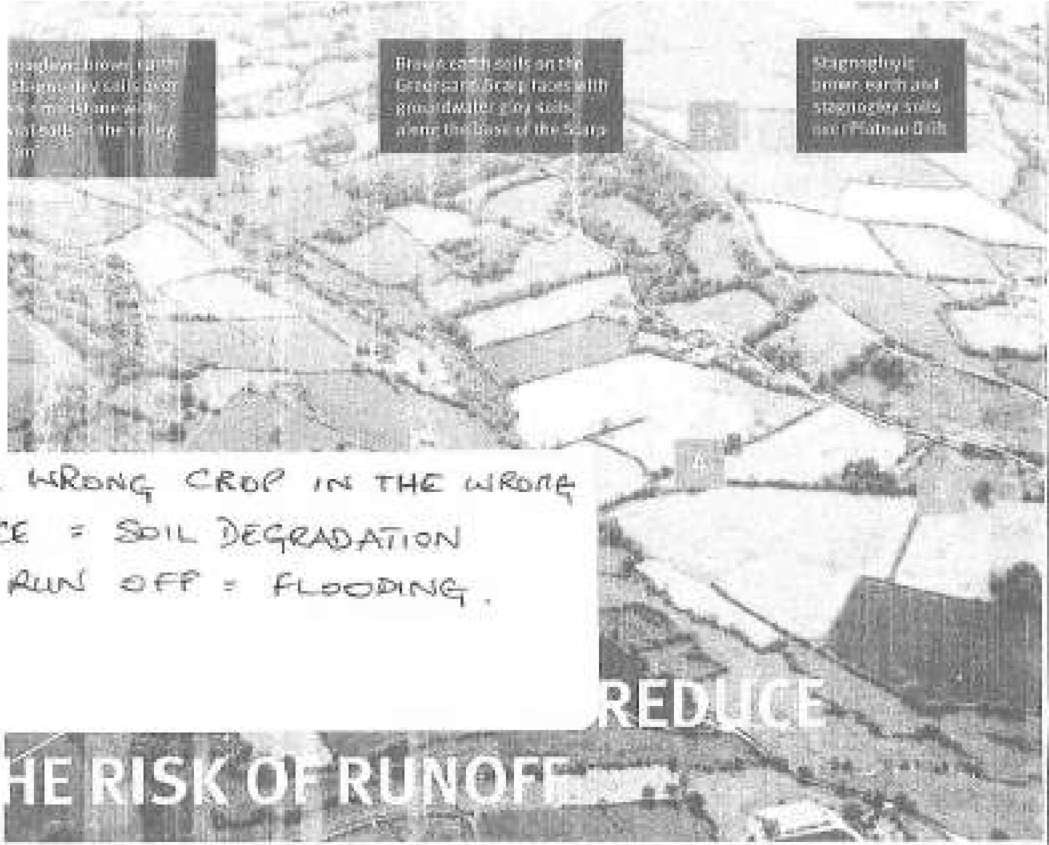
A 3 hectare field can therefore potential
generate 300,000 litres of overland flo
during 10mm of rainfall in 1 hour.

UNNATURAL SOIL WATER MOVEMENT

LOW RAINFALL ACCEPTANCE POTENTIAL

COMPACTION 2

UNNATURAL SOIL WATER MOVEMENT



THE WRONG CROP IN THE WRONG PLACE = SOIL DEGRADATION = RUN OFF = FLOODING.

REDUCE ...HE RISK OF RUNOFF

...y draining soils in the Vales and Combes of East Devon ...ell suited to livestock farming on grassland particularly ... farming.

...e crops are suited to some of the better drained land with ... sheltered slopes, cereal crops can be grown without ...ng damage to soil with careful timely management. ...sting maize in the autumn, however, almost inevitably ...ges soil structure, and following crops and grass reseeds ...ten established late in the year in seedbeds overlying ...e compacted slowly permeable subsoils.

...land helps produce good soil structure with dense ...g and abundant earthworms maintaining friable stable ...ils. However, slurry spreading in winter readily compacts ... or wet soil, kills soil life, and nutrients can be washed ... within enhanced runoff. The provision of sufficient winter ... storage allows slurry to be used as an effective fertiliser ... applied in dry conditions in summer without damaging

Maize should never be grown on stagnogley soils as they naturally lie wet for long periods of the year and it is impossible to harvest without seriously damaging soils. On better drained ground, very early maturing varieties should be chosen to enable a September harvest which should allow groundwork to be carried out in dry soil conditions. Starting maize under film can bring the maize harvest forward.

SOIL COMPACTION

Degradation of soil structure where the soil becomes compacted and impermeable can lead to unnatural or enhanced runoff. Upper soil layers above the zone of compaction readily become saturated after rainfall. However, the deeper soil profile below the compaction remains relatively dry, so the full potential of the soil to accept rainfall is lost.

Modern farming has the ability to change soil structure and hydrology across large areas of the landscape very quickly, and there is increasing evidence to demonstrate that this is happening in the South West.

Soil compaction can be subtle. It is not necessarily restricted to the obvious impact that is seen for example concentrated around gateways. Less severe compaction occurs within fields and can be found at various levels in the soil profile. All compaction restricts downward water movement and can lead to surface saturation and the potential for the generation of surface runoff. This may not necessarily radically affect crop yield so may not be a high priority for the farmer, but it can have major consequences off the farm.

SOILS AND FLOODING

Surface water flooding

[illegible]

[illegible]

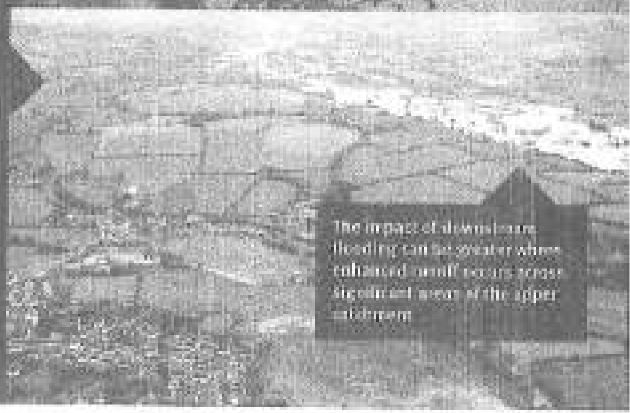
Fluvial flooding

[illegible]

[illegible]

Soil compaction in some years can be widespread and where this occurs on land that would normally accept rainfall, then runoff can be greatly enhanced

Rapid runoff can produce high volumes of water in a short period which can lead to flooding



The impact of downstream flooding can be greater where enhanced runoff occurs across significant areas of the upper catchment

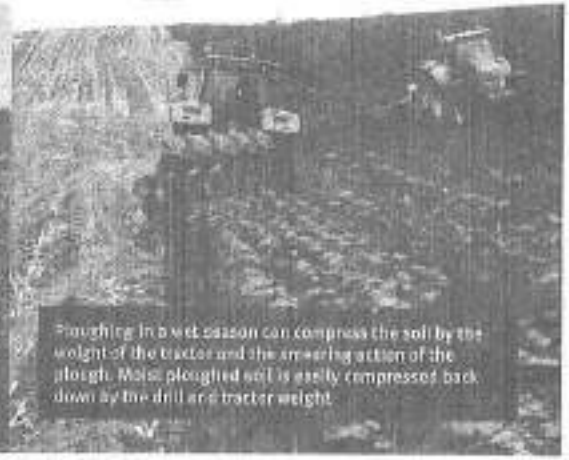
SOIL COMPACTION

Soil compaction is a common problem [redacted], and it can be widespread whenever the major land working periods during spring and autumn are unseasonably wet.

Timeliness in working the soil when moisture conditions are suitable is down to the good judgement of the farmer. Working land in less than ideal conditions is unavoidable with some crops, and also when weather conditions suddenly change or are not ideal.

Moist, plastic soil that can be moulded is at high risk of compaction

Ploughing and drilling of crops in a dry season. Dry soil can withstand the weight of the tractor and plough. Drilling into friable soil also produces more durable, small aggregates in the seedbed

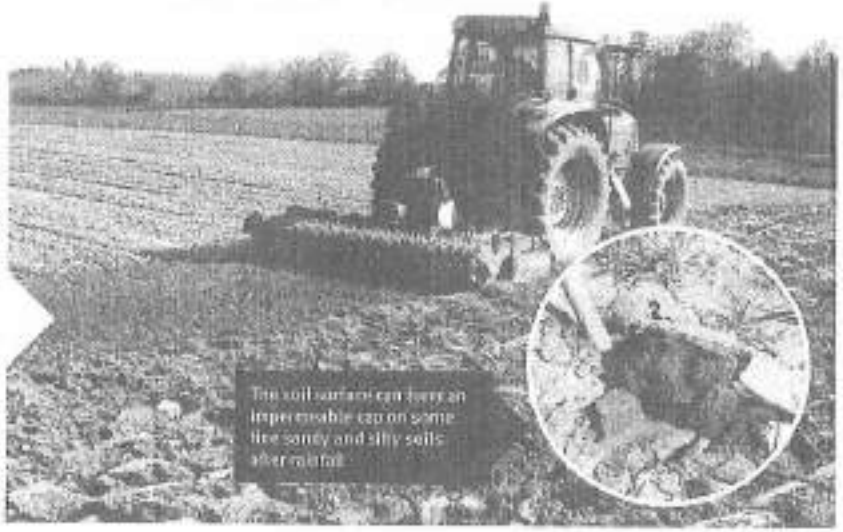


Ploughing in a wet season can compress the soil by the weight of the tractor and the smearing action of the plough. Moist ploughed soil is easily compressed back down by the drill and tractor weight

SURFACE CAPPING

Capping has a high risk of occurring on the surface of seedbeds that have been worked to a fine smooth tilth and where soils have a high fine sand and silt content.

It particularly occurs where seedbeds have not dried out (locally know as pitching off) before the onset of rainfall. Dry stable aggregates are more resistant to dispersal than moist soil particles which readily fall apart during rainfall.



The soil surface can form an impermeable cap on some fine sandy and silty soils after rainfall

SOIL COMPACTION

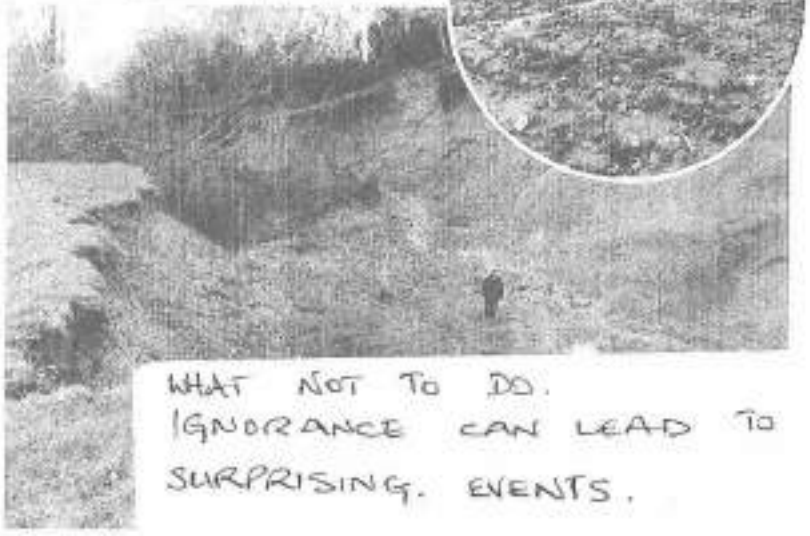
Soil compaction is often associated with travelling on land when the soil is very moist or wet. In wet years, soil loosening after late-harvested maize will not fully counteract the affects of deeper compaction. Loosened topsoil can fill with water causing overland flow and erosion.

Late drilled crops after maize can compound existing soil compaction. They have poor crop cover throughout the winter and often cause runoff and pollution of nearby watercourses.

LANDSLIP

Sudden spectacular landslips can occur on the Greensand Scarp where the soil becomes super saturated with water originating from enhanced runoff generated by damaged soils on the Plateau above.

Large volumes of sand eroded from these slips can smother watercourses, fish habitats and cause serious damage to roads and property downstream.



WHAT NOT TO DO.
IGNORANCE CAN LEAD TO
SURPRISING. EVENTS.