Soil conservation evaluation

Methodology

Soil erosion is monitored with simple, low cost, low tech but reliable methods using soil pins and sediment traps. NOMAFSI staff was trained and became proficient in these methods during an informal training program conducted mid 2009 shortly after the onset of the wet season. A comprehensive document describing the method was developed and circulated following the training session. This included description on setting up, maintaining and monitoring erosion as well as data handling.

Erosion assessment

The soil pin method assesses changes in micro elevation within a fixed 0.7 x 1 m quadrant (erosion station) installed inside an eroding field. (NB the size of the quadrant is set to also allow photogrammetric monitoring of erosion). The change in micro elevation is monitored at 8 fixed locations inside the quadrant. Changes over time in average micro elevation are due to soil erosion/deposition, swelling/shrinkage of soil and slumping on freshly tilled soil. The method assumes that soil erosion is the largest factor resulting in a decrease in micro elevation. Given that measurements are repeated over time, changes in soil water content, i.e. shrink/swell processes should be negligible. Slumping of freshly tillage soil will overestimate erosion, but will only be significant until the soil surface consolidates after tillage. It is possible to adjust for slumping by measuring bulk density of the tilled soil and again after the soil consolidated. NB At present no bulk density equipment is available, however benchmarking of soil erosion was conducted well after soil was tilled and slumping had ceased.

The corners of each erosion station are four 60 cm long steel pins pushed into the soil to about ½ a meter. We assume that the depth of insertion remains constant during the monitoring; hence the pins become a fixed reference point. An aluminium lath is placed diagonally over two pins. The lath has 4 fixed points at which the distance between lath and soil surface is measured using a ruler. A second set of 4 measurements is taking after rotating the lath 90 degrees to the other two pins, thus 8 distance measurements are obtained. It is critical that the lath is always placed on the pins in exactly the same location and distances measured at the same points to ensure that changes in soil micro relief are monitored at the same fixed points.

Erosion traps are at a short distance below the erosion stations. They comprise two 10 cm diameter 20 cm tall PVC tubes, sealed with plastic bags at the bottom to trap runoff and collect sediment. The main purpose is to show how much soil moves down the slope; collection of qualitative data is limited because it the area over which the runoff is trapped is not known.

During the installation of erosion stations background data, e.g. GPS, groundcover and phonological stage of maize was recorded. It is important to note that maize was already well established when erosion stations for the benchmarking study were set up.

A composite soil sample was collected from the outside corners of each erosion station. If necessary, a subset of samples will be analysed to see how soil properties such as e.g. organic matter affect erosion.

Soil analysis

Soil samples are analysed at the UQ labs following the Australian standard soil analysis published in: Australian laboratory handbook of soil and water chemical methods / G.E. Rayment and F.R. Higginson. Publisher Melbourne: Inkata Press, 1992.

Collection of plant samples has/will commence as the erosion trials precede.

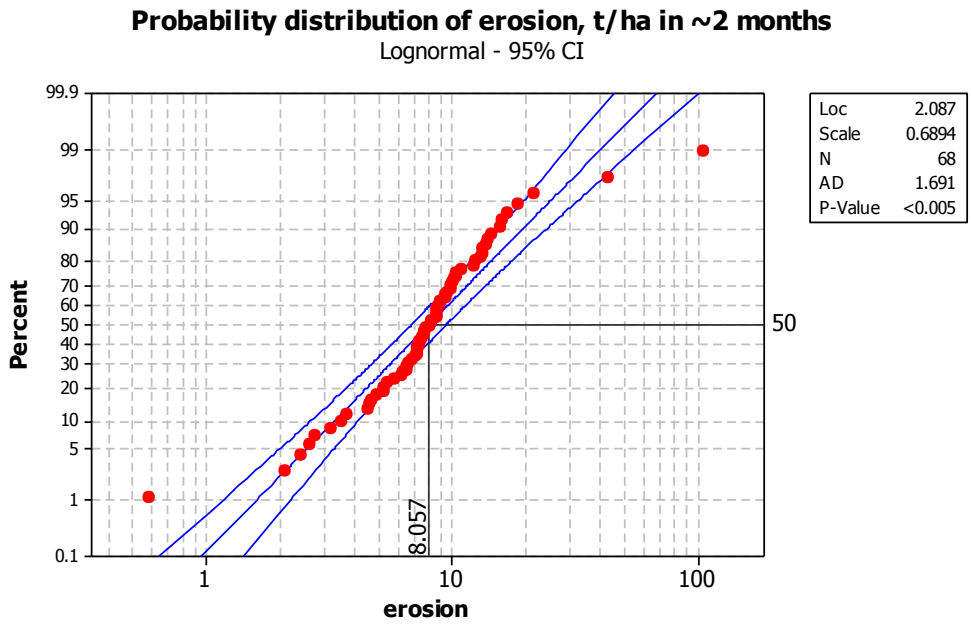
Results

Erosion benchmarking

The erosion stations were installed early July 2009 and monitoring commenced end of July 2009. A total of 80 erosion stations was set up, half in Son La and the other half in Lai Chau province, however some of them were lost or pins were removed by the farmers for alternative use.

In Son La there were two districts (Moc Chau and Mai Son) with one commune with one village in each district (La Nga in Muong Sang and Na Ha in Na Ot). In Lai Chau there were also two districts. In Sin Ho district the communes Ta Ngao with villages Giang Ma and Ban Hai Ho; in Tam Duong district the commune Sin Chai with villages Giang Ma and Ho Thau.

The erosion sites were monitored 4 to 5 times until the end of the wet season and maize harvest end September 2009. Erosion during the last months of the maize season was low and ranged from less than 1 to over 100 t/ha, with and average of around 8 t/ha; slopes of the fields ranged from 7° to 43°, with an average of 20°.

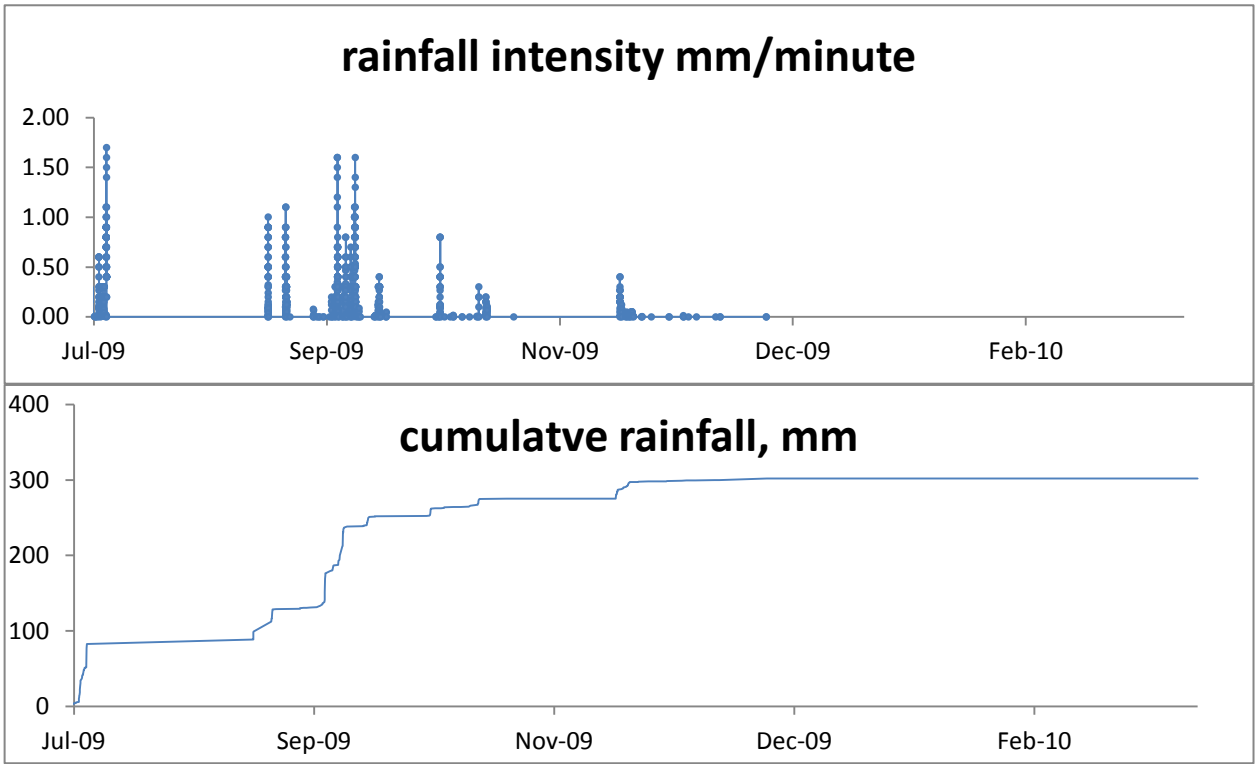


Erosion rates were log-normal distributed showing that an even spread of fields with varying erosion rates was selected and assessed. There were no significant differences between provinces, communes, sites and slopes:

District	Mean t/ha	SE Mean
Mai Sơn	11.0	3.5
Moc Chau	7.5	2.9
Sin Ho	14.5	3.3
Tam Đường	10.3	3.1
	P=0.47	

Although GPS coordinates for each erosion station was recorded, only the data for Son La is useable, all coordinates for Lai Chau are in Laos, possible due to GPS malfunction.

Rainfall was only recorded in one of the four sites, partly due to logger failure. The rainfall intensity and total rainfall recorded at Tam Duong is given below.

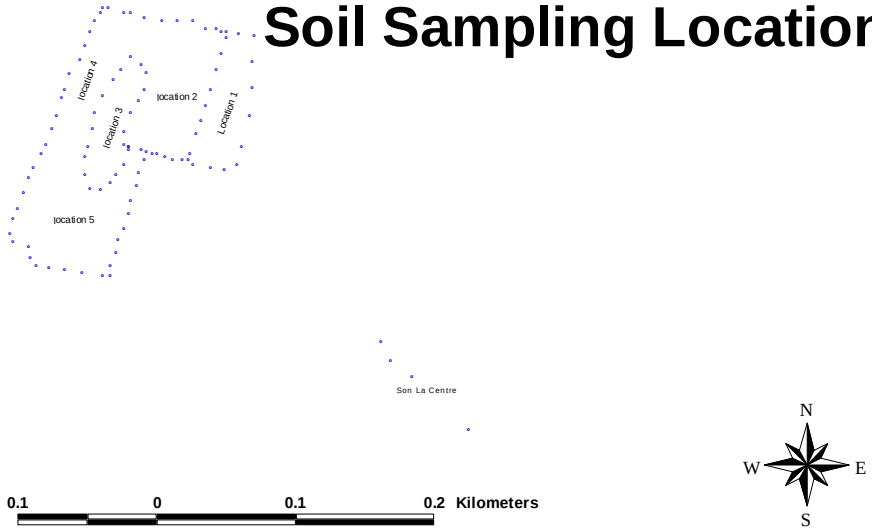


These relatively low intensities as well as quite low total amounts of rainfall are likely to result in low erosion rates. For example, it is not unusual for rainfall intensity in the Lockyer valley to exceed 5 mm/min. If the rainfall pattern at Tam Duong is an indication of rainfall elsewhere, this would be a contributing factor for overall low erosion rates after the wet season has commenced. It is important to note that erosion at the onset of the wet season while fields were cultivated and bare, was not recorded, which is the most crucial time for erosion assessment. Our data shows that erosion well into the wet season is low with only in excess of 20 t/ha on 5% of the sites.

Soil analysis

Soil samples were collected by PPRI in plum orchards in Pieng Sang village, Moc Chau district in January 2010. Samples were taken from 3 orchards at 3 depths 5-15 cm, 25-35 cm and 55-65 cm. Samples were also taken in March 2010 at Son La station where the Maize systems trials were established. There were 3 orchard There were 5 sampling locations at Son La station and one composite sample taken from each location at 0-10 and 10 – 40 cm depth. These samples have been analysed for major cations, CEC, total N and C, Colwell P, S, B and DTPA extractable micronutrients.

Son La
Experimental Station
Soil Sampling Locations



Analysis results are given on the next page.

The interpretation of analytical results are based on ‘Soil Analysis – an Interpretation Manual (2005) Edited by KI Peverill, LA Sparrow and DJ Reuter, CSIRO publishing’, and ‘Interpreting Soil Test Results (2009) by Pam Hazelton and Brian Murphy, CSIRO Publishing). It is important to note that threshold values used are generally based on Australian soils and ideally soil tests need to be calibrated for crops, soils and environments. It is particularly important to note that very little specific data exists for stone fruit grown in tropical high altitude environments.

Most soils are slightly acid and could benefit from liming, except location 3 in Son La where we also observed marl in the soil profile. However, the effect of lime application is not immediate and small amounts should be applied on a yearly or bi-yearly basis which would also reduce further acidification from product removal. Organic carbon levels are adequate but due to the low CEC an increase in organic matter would be beneficial as it is likely to improve CEC. In the maize system, not burning would be an important step towards increasing organic matter while mulching would be suitable for the orchards. Increasing organic matter would also address the problem of low total N-value in some soils.

Site	Sample	pH	EC	OC	TN	C:N ratio	Col P	Ca	K	Mg	Na	CEC	SO_4-S	B	Cu	Fe	Mn	Zn
	Mar-10		dS/m	Wt %	Wt %		mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Orchard	DVC55-65	7.25	0.133	0.58	0.084	6.954	25	6.96	0.32	3.73	0.02	11.02	12.1	0.666	1.4	15.7	31.6	0.7
Orchard	DVC25-35	6.88	0.129	1.97	0.154	12.766	50	6.78	0.29	4.09	0.01	11.17	49.6	0.577	2.7	26.4	42.4	1.6
Orchard	DVC5-15	7.37	0.081	2.65	0.223	11.874	57	8.43	0.42	4.68	0.01	13.54	21.1	0.492	2.9	40.0	35.8	2.2
Orchard	TVS25-35	4.76	0.023	1.54	0.186	8.308	31	2.09	0.79	0.79	0.04	3.71	29.4	0.281	1.6	24.6	58.1	0.6
Orchard	TVS5-15	4.97	0.064	2.02	0.222	9.096	45	2.79	0.25	0.87	0.02	3.93	16.7	0.236	2.6	49.1	91.2	1.9
Orchard	TVS55-65	5.10	0.030	0.92	0.131	7.052	20	1.98	0.18	0.71	0.02	2.89	24.5	0.207	0.2	7.7	5.3	0.1
Orchard	TVD25-35	4.91	0.030	1.57	0.161	9.795	34	1.59	0.17	0.36	0.03	2.14	25.4	0.228	1.9	32.3	81.4	0.7
Orchard	TVD55-65	5.60	0.019	0.76	0.096	7.902	20	1.09	0.10	0.19	0.05	1.43	20.9	0.172	0.6	18.8	38.0	0.1
Orchard	TVD5-15	5.06	0.040	2.62	0.253	10.336	60	3.28	0.55	0.84	0.01	4.68	17.9	0.199	2.2	53.8	119.9	2.2
Son La	1 0-10	4.55	0.052	2.62	0.218	12.039	34	1.40	0.36	0.39	0.01	2.14	23.3	0.122	0.4	22.5	5.7	0.2
Son La	1 10-40	4.61	0.031	1.62	0.136	11.941	31	1.14	0.15	0.28	0.01	1.57	29.1	0.134	0.2	9.0	2.3	0.1
Son La	2 0-10	4.79	0.050	2.37	0.197	12.041	29	2.18	0.40	0.59	0.01	3.16	29.8	0.106	0.6	13.3	7.8	0.2
Son La	2 10-40	4.93	0.022	1.61	0.146	11.004	14	1.97	0.09	0.59	0.00	2.66	18.6	0.151	0.5	10.2	1.8	0.0
Son La	3 0-10	6.34	0.072	2.27	0.180	12.656	44	11.16	0.49	1.67	0.00	13.32	8.4	0.107	1.5	15.2	14.9	0.4
Son La	3 10-40	6.70	0.045	1.53	0.125	12.243	15	10.49	0.11	0.98	0.04	11.63	7.1	0.092	1.5	9.4	8.6	1.3
Son La	4 0-10	4.77	0.065	2.42	0.187	12.908	37	1.94	0.44	0.54	0.00	2.93	25.1	0.189	0.7	28.6	5.5	0.3
Son La	4 10-40	4.59	0.053	2.28	0.172	13.252	26	1.45	0.15	0.36	0.01	1.97	27.8	0.135	0.5	29.8	2.7	0.2
Son La	5 0-10	4.66	0.059	2.19	0.179	12.209	34	1.78	0.29	0.59	0.01	2.65	17.5	0.101	0.8	23.6	15.5	0.2
Son La	5 10-40	4.47	0.055	1.94	0.148	13.133	25	1.10	0.14	0.32	0.00	1.56	19.8	0.111	0.7	18.4	5.9	0.1
		for orchards	<0.15	moderate	medium	medium	normal	moderate	moderate	moderate	moderate	moderate		probably ok if	probably ok if	probably ok if	probably ok if	probably ok if
		6-7.5		1-1.8	0.15-0.25	15-25	30-50	5-10	0.3-0.7	1-3	0.3-0.7	15-25	>6	0.1-1	>0.5	>5	5-100	0.2-1
		maize																
		5.5-7																

NB: Orchard samples: DVC=Dang Van Chien, TVS=Trieu Van Song and TVD=Tang Van Dan, sample locations for Son La correspond to the map.

Basic cations are also low due to the low CEC. Some increase in Ca can be expected from lime application as well as standard NPK fertiliser which would also address the low P status on some sites. Levels of micronutrients tend to be adequate at most sites, but it may be possible to test if foliar sprays impact on plant growth on those sites where levels are low. It is important that these results are not interpreted in isolation, but need to be assessed together with foliar analysis and yield formation.

Conclusions

Erosion rates after the onset of the wet season and on fields where maize is well established are low and well within what is normally considered acceptable levels of soil loss. This can be attributed to maize foliage projection cover and possibly relatively low rainfall intensity. It is fair to assume that the vast majority of soil loss occurs when the wet season commences and high intensity rain falls on bare ground before the maize crop is established. Any maize based system should aim to have ground cover when the rains commence, this applies to maize mono-crop as well as maize rotation and/or intercropping. The latter on its own will not address soil erosion unless the soil surface is protected, possibly using dead or life mulch. Not burning the fields is the first step for conservation farming practises. A main impediment for inclusion of other plants in the fields, be it an additional crop, intercrop or cover crop, is the lack of immediate benefit to the system which is primarily based on maize mono-cropping with little current interest in diversification. One of the potential problems with live or dead mulch may be animal grazing during the dry season. It will be important to assess how much of a limiting factor this may be for mulch retention.

Discussion and follow up

Discussion

The main shortcoming of the benchmarking dataset is the lack of data at the onset of the wet season. This should not be the case this year and monitoring of erosion and rainfall is expected to strengthen the observations from last year. Some field equipment is still missing which is needed to complete all parts of the work plan.

Experimental protocol for follow up trials

A generic work plan detailing the preparation, setting up, sampling and monitoring procedures of the erosion trials was written in March 2010 (see last 5 pages of this appendix). This was combined with staff training to ensure that all tasks can be carried out for a successful running of the trials. This work plan was circulated to all research staff who are involved in the erosion trials with and understanding of active data exchange as monitoring data becomes available. No data exchange has occurred this year. As data becomes available and/or problems are encountered, it would be of benefit if e-mail communication between Vietnamese field researchers and their Australian counterparts would increase. This would also encourage discussion and simplify data analysis. The Australian team will put effort to improve data exchange in the future. Regular visits to erosion trial sites are planned for this year by Australian team members.

At present there are erosion trials in Son La and Lai Chau. In La Nga village in Muong Sang community we have 4 treatments (control, mulch, pinto, mini terraces) with 3 replicates. In Na Ha village in Na Ot community we have 3 treatments (control, mulch, mini terraces) with 3 replicates. In Lai Chau we have erosion trials in Giang Ma village (Tam Duong) and Lang Mo village (Sin Ho district). In both villages experiments have 4 treatments (control, mulch, pinto, mini terraces) and 3 replicates. Farmers in Lang Mo village showed no interest in erosion trials at this

stage so no farmer researchers were involved in the trial. However we hope farmer's attitude will change as a result of this year trial.

Appendices

Erosion measurement protocol is described in a separate document with file name: Setting up and measuring erosion v1.doc (3.2Mb, 12 pages)

Erosion trial protocol: file name: Soil erosion trial setup v1.doc (48Kb, 6 pages) double-click box to access.

Soil erosion trial setup – generic work plan

As on 14 March 2010

This list is not complete and should be updated as we go – these plans always evolve due to things we forget and cannot foresee ☺.

Sites:

Son La:
Moc Chau – Muong Sang – La Nga (Thai ethnic), *4 treatment (control, mulch, pinto, mini terraces*
Mai Son – Na Ot – Na Ha (Thai ethnic), *3 treatment (control, mulch, mini terraces*
Lai Chau : (TBA)
Sin Ho – Lang Mo – Lang Mo (Hmong)
Tam Duong – Giang Ma – Giang Ma (Hmong)

Equipment/resources

Plot layout

Pegs to set up plots

Long tape measure

GPS and clinometer

Spade/shovel

Plastic bags (soil sampling)

Climate

4 Pluviographs

Davis weather stations (to be purchased)

Erosion set up

Erosion pins (metal and/or bamboo)

Ruler

Aluminium profile beam

Sediment collection flasks

Rubber bands

PVC (~ 15 cm tall, ~ 20+ cm diameter) rings for infiltration measurements

Hand help TDR

Hammer and wooden board.