Estimating the Value of Agricultural Cropland and Pastureland

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Motivation

- ❑ **Agricultural sector –**

- ○ Agricultural land - 57% of the geographical area of India

- ○ Contribution to India's GDP has ↓ from 50% in 1951 to 20% in 2003 (including the allied activities).

- ○ In comparison –

- ○ manufacturing ↑ from 15% to 24%,

- ○ Services ↑ from 29% to 51%.

- ❑ **Considerable transformation in the agricultural sector**

- ○ ↑ in fertilizers, pesticides, irrigation, better-quality seeds, etc.

- ○ Manifold ↑ in pesticides and fertilizers per tonne

- ○ The gross area sown has ↑ very slowly.

- ○ Agricultural land suffers from indiscriminate conversions

Some facts

- Per capita availability of agricultural land ↓ from 0.48 ha in 1951 - 0.14 ha in 2001.
- Food grain production ↑ from 50 MT in the 1950s - 209 MT in 2001.
- Fertilizer consumption ↑ from 0.3 MT in the 1960s - 16 MT in 2001
- Pesticide consumption ↑ from 2353 T in the 1960s to 48 350 T in 2001.
- ↑ in use → serious environmental degradation
- 53% of land (around 174 M ha) suffers from varying degrees of degradation.
- Around 800 ha of arable land is lost annually due to the ingress of ravines.
- The average loss of topsoil due to erosion is 19.6 t/ha
- Direct bearing on food production and livelihood of the people.

Agricultural impact on environment
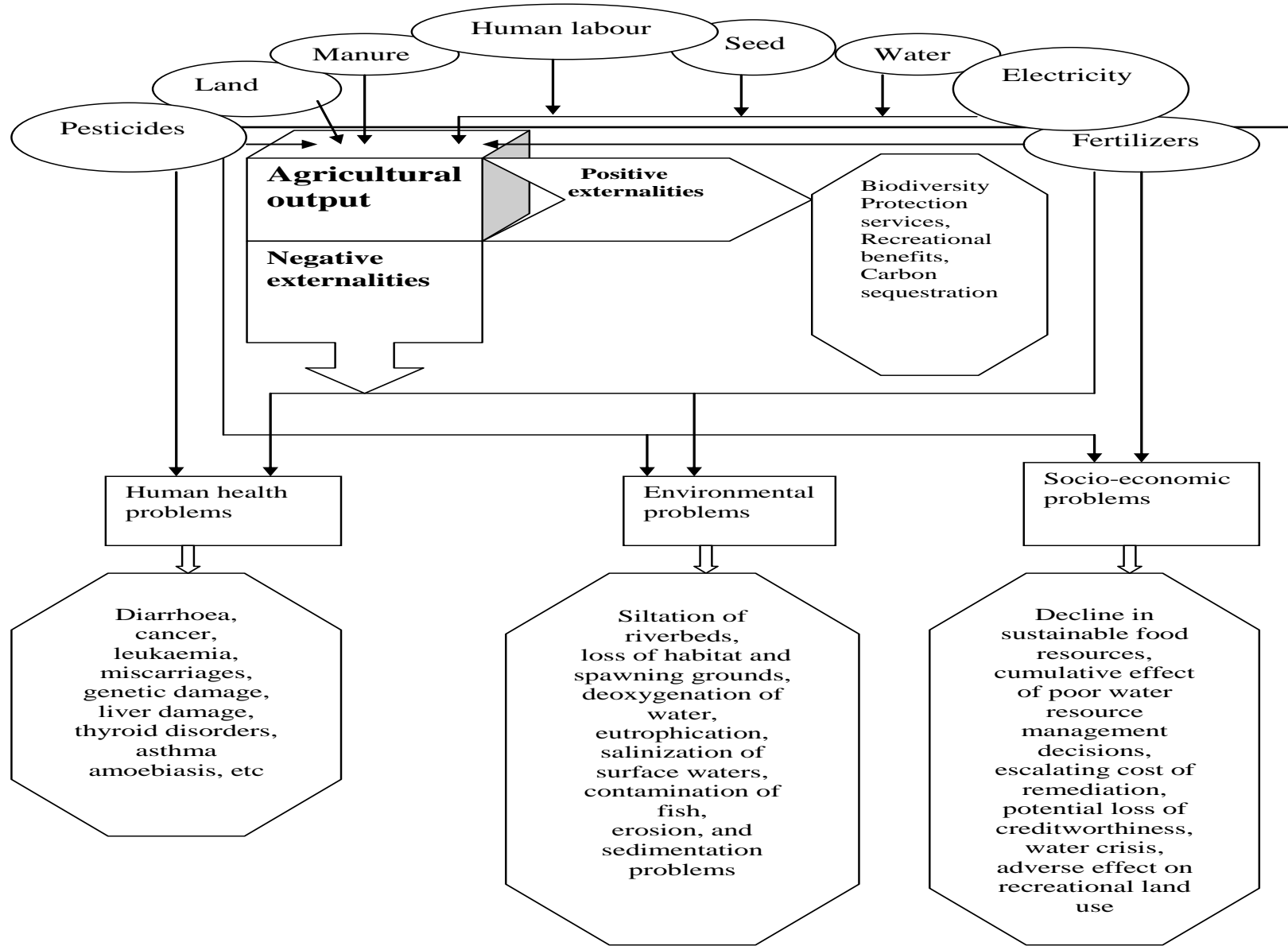
Motivation

- Impact of agricultural land on environment not reflected in the national statistics

- Agricultural land - treated as a non-produced economic asset which provides economic benefits to its users.

- Aggregate statistics do not show any alarming signal as problems relating to agriculture are micro-level

- Need to revise macro level estimates

- - improved understanding of the economic implications of the sector's impact on the environment.

- - Assess the sector's net contribution to the economy

- - Analyze the sustainability of the growth

- - Identify the corrective measures if growth is unsustainable

Objective of the study

❖ Develop an accounting framework that reflects the real contribution of agricultural and pasturelands' contribution to the society.

❖ Specific objectives:

➢ 1) Estimate the value of the stocks and flows of agricultural land and pastureland.

➢ 2) Incorporate the loss in value caused due to depletion of agricultural and pastoral resources into the national accounts.

➢ 3) Estimate the impact of the sector on the degradation of the environment and thereby estimate the sector's real contribution to the economy.

Scope of the present work

- We mainly consider the impact of agricultural production on land degradation, soil erosion and sedimentation of water ways

- Impact of fertilizers and pesticides are outside the scope.

Framework for Accounting

Opening stock	Land under cultivation and pastures in the opening year
Changes in quantity	Asset increase due to land reclamation/improvement
	Transfer of land from economic use to environment
Other accumulation	Changes in land use
	Transfer of land from environment to economic use
Other volume changes	Changes due natural, political or non economic causes
Closing stock	Land under cultivation and pastures in the closing year
Changes in quality of land	Soil erosion or nutrient loss (in tonnes)
	Land/soil contamination including soil salinization and other changes in soil quality
Impact on other sectors of the economy	Extent of sedimentation in waterways

Data Sources

○ Agricultural Statistics published by the Ministry of Agriculture (Agricultural and pasture land area)

➢ Statistical abstract of India (land use change matrix)

➢ Changes in quality of Land

➢ Wasteland data available from different sources – UNEP, Ministry for agriculture, NRSA (2000, 1989), SPWD (1984).

➢ We took data from NRSA (2000) and adjusted for already existing degraded lands.

➢ Only data on gullied/ravenous lands, upland with or without scrub, water logged and marshy land, land affected by salinity and alkalinity, shifting cultivation, degraded pasture and grazing land considered in the paper.

Data Sources

- Land degradation takes place largely in the form of soil erosion – On site (soil loss), Off-site (sedimentation of waterways)
- We used data from **Singh, Babu and Narain et al. (1992)** – soil erosion rates for different regions of India
- Erosion rate contributed by each state - computed using the share of agricultural area in each state to the total in India
- For Sedimentation of waterways, we used the study Sharma (2002)
- The study gives sediment load per square kilometre per year for all major rivers and their tributaries in India and Nepal
- Sediment load of the different rivers in different states estimated using the length of rivers in different states
- Contribution of agriculture to sediment load estimated based on the proportion of land degraded as a result of agricultural activities in the total geographical area of each state.

Methods used in Valuation - Land

- Complications in valuing land
- We used net present value approach (suggested by SEEA)
- Land rent is the annual net returns from the use of the resource over time, less a reasonable allowance for profit

$$NPV = \sum_{n=1}^{T} \frac{LR_n}{(1+i)^n}$$

- NPV - net present value of the asset in year n;
- T - economic life of the resource;
- i - the discount rate; and
- LRn - land rent in year n.

- Change in the value of assets (depreciation)
- - measured as the difference between the asset value at the beginning of the year and that at the end of the year.

Valuation of Land

- Net present value of land estimated from the data on the value of output in agriculture from 1950/51 to 2000/01.
- Used a liner regression model using time as an independent variable and the value of output as the dependent variable.
- Predicted the average future net returns using this trend variable (time)
- Two different discount rate 4% and 10% were used.
- Netted out agricultural subsidies.
- Lifespan of the land was assumed to be 30 years
- Sensitivity analysis was carried out for different time frame (50 years) and discount rate (10%) as well
- No assumption was made about the value of agricultural land at the end of the lifespan

Value of Land Degradation

- Whole resource rent cannot be considered as income.
- if land is used unsustainably - adjustment to income necessary
- Changes in the quality of land can be captured through the lost output (productivity loss) approach/Maintenance cost
- Following assumptions made for productivity loss approach
- For waterlogged/marshy land – 40% loss in productivity
- We assumed that this loss is already reflected in the national accounts
- For gullied and ravenous lands, uplands with or without scrub, degraded pastures and grazing land and others – entire productivity loss
- For using maintenance cost method, the expenditures incurred in repairing and rehabilitating degraded land from Ix th plan onwards and estimated the average cost

Value of Soil Erosion

- We used replacement cost approach
- Nutrient loss estimated from the volume of soil lost annually
- Nutrients considered - Nitrogen, Phosphorus, and Potassium .
- Values of available N, P. K estimated in terms of the equivalent levels of urea (46 0 0) for Nitrogen
- Single super phosphate or P2O5 (0 16 0) – for Phosphorous
- Murate of potash or K2O (0 0 60) – for Potassium.
- Valuation was done using the price of fertilizer per kilogram of nutrient published by the Fertilizer Association of India (2000).
- The nutrients lost were multiplied with the price of fertilizer per kilogram of the nutrient to get the replacement costs.

Cost of Sedimentation

- For the cost of sedimentation we used the maintenance cost approach.

- There are mainly three methods

- —sediment sluicing, flushing and dredging — to reduce the amount of sediments flowing into the reservoir, thereby prolonging the life of the reservoir.

- A study by Mahmood ([1987] cites the cost of dredging at 2–3 dollars per cubic metre in 1987 - around 20 times more than the cost of providing additional storage in a new dam.

- We used this value (after adjusting for inflation) as an approximate cost incurred in removing sediments.

Monetary accounts and adjustment in national accounts

- All the physical accounting entries are multiplied with the corresponding value to obtain the monetary estimates

- As the difference in opening and closing stocks could be because of the change in prices used, we introduced the revaluation term – in case of quantity accounts

- Accounts were adjusted as follows

- Depletion = change in value of agricultural land and pasture land

- Degradation = replacement cost of soil nutrients + cost of sedimentation + cost of rehabilitating lands

- ESDP = adjusted SDP after agricultural subsidies + total adjustment for depletion and degradation

Value of changes in quantity and degradation of land (Rs. Millions)

| State	Changes in quantity of land	Cost of land reclamation	Replacement cost of soil nutrients	Cost of sedimentation	Total adjustment for depletion &degradation	Value added by agriculture adjusted for subsidies
AP	696.143	372.51	17671.75	974.61	-17720.6	260464.25
AruP	0.288	137.29	253.27	1594.25	-527.57	4639.87
Assam	6.828	209.12	4569.06	1520.53	-4980.48	110688.71
Bihar	251.675	106.41	12092.97	3770.32	-12054.1	245621.95
Goa	0.049	5.37	233.01	1.05	-243.71	4676.47
Gujarat	-109.07	535.03	16180.81	495.86	-17359.9	149941.63
Haryana	4.653	36.49	5865.82	710.67	-5934.15	143289.92
Himachal P	39.018	103.45	967.51	420.26	-1135.38	29802.78
J and K	2.528	80.39	1232.6	785.47	-1390.85	39079.66
Karnataka	-156.13	154.12	18215.44	1904.52	-18679.8	222145.15
Kerala	-24.522	7.96	3799.1	74.61	-3839.54	110391.75
MP	-244.55	720.12	32996.49	30799.46	-34681.3	250131.23
Maharashtra	-508.74	562.75	30426.61	9245.83	-32060.8	388527.63
Manipur	0	197.19	236.39	1.29	-630.77	5037.35
Meghalaya	0.608	100.55	339.39	68.58	-539.88	7564.11
Mizoram	0.47	60.1	109.75	1.01	-229.49	3743.57
Nagaland	2.134	109	344.45	85.64	-560.32	10825.41
Orissa	-315.57	145.48	10644.25	1043.81	-11250.8	115441.97
Punjab	110.792	18.33	6988.66	643.79	-6914.53	209986.42
Rajasthan	-920.14	756.29	28599.66	20002.11	-31032.4	124460.52
Sikkim	0	10.99	160.41	15.43	-182.39	4273.02
Tamil Nadu	-429.33	17.15	9815.2	61.16	-10278.8	139885.7
Tripura	0.507	175.6	452.52	0.23	-803.22	13898.45
UP	796.094	312.34	29141.66	14756.03	-28970.3	618720.73
WB	-90.256	61.76	9276.57	1512.49	-9490.35	356060.7
UTS	-1.324	1.64	241.45	0	-246.06	9450.79
Total	-8878.3	4435.9	240854.8	90489	-258605	3578749.8

Environment adjusted State domestic product/Net state domestic Product
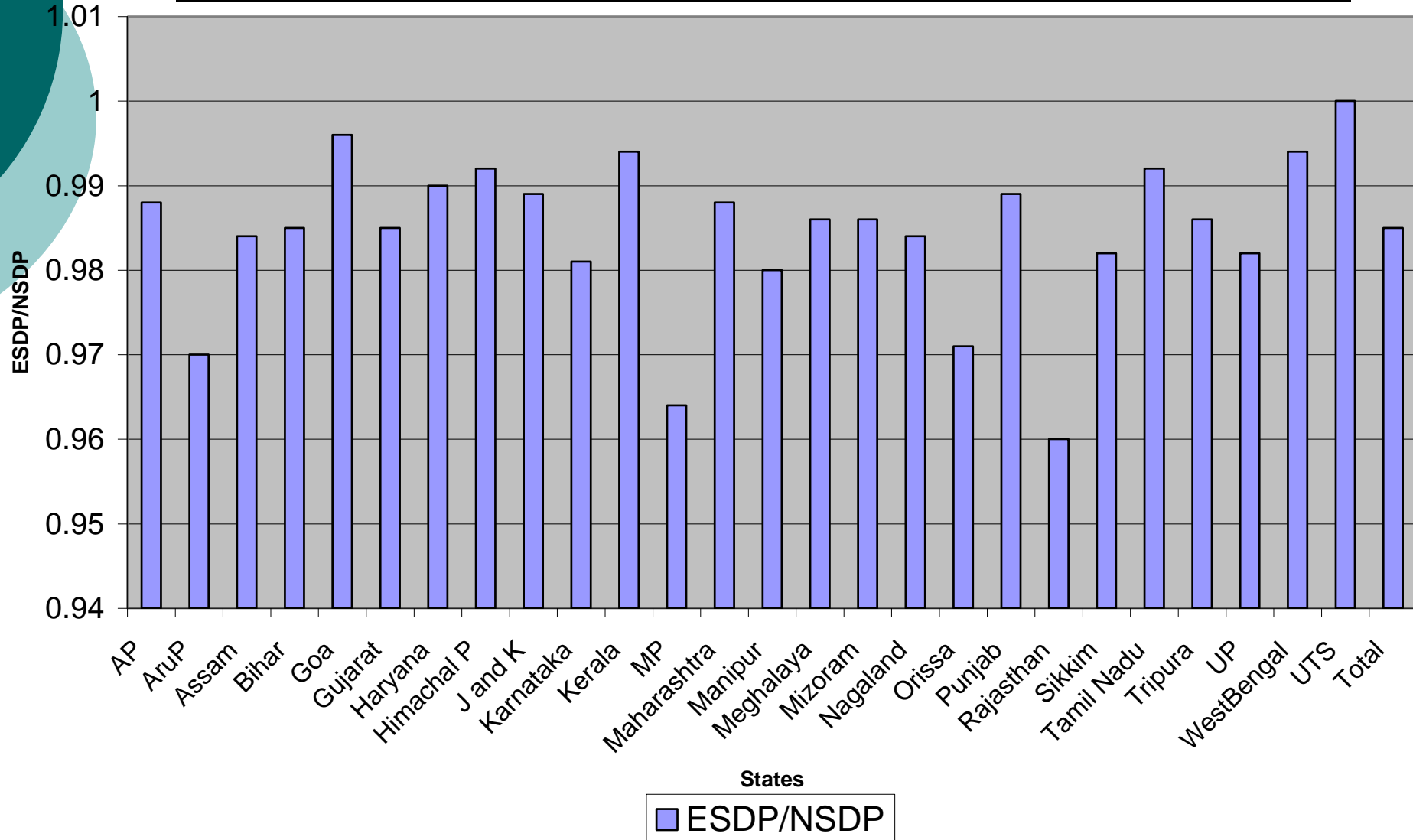
Depletion and degradation as per cent of NSDP (adjusted for subsidies)

Depletion and degradation as per cent of ESDP (adjusted for subsidies)
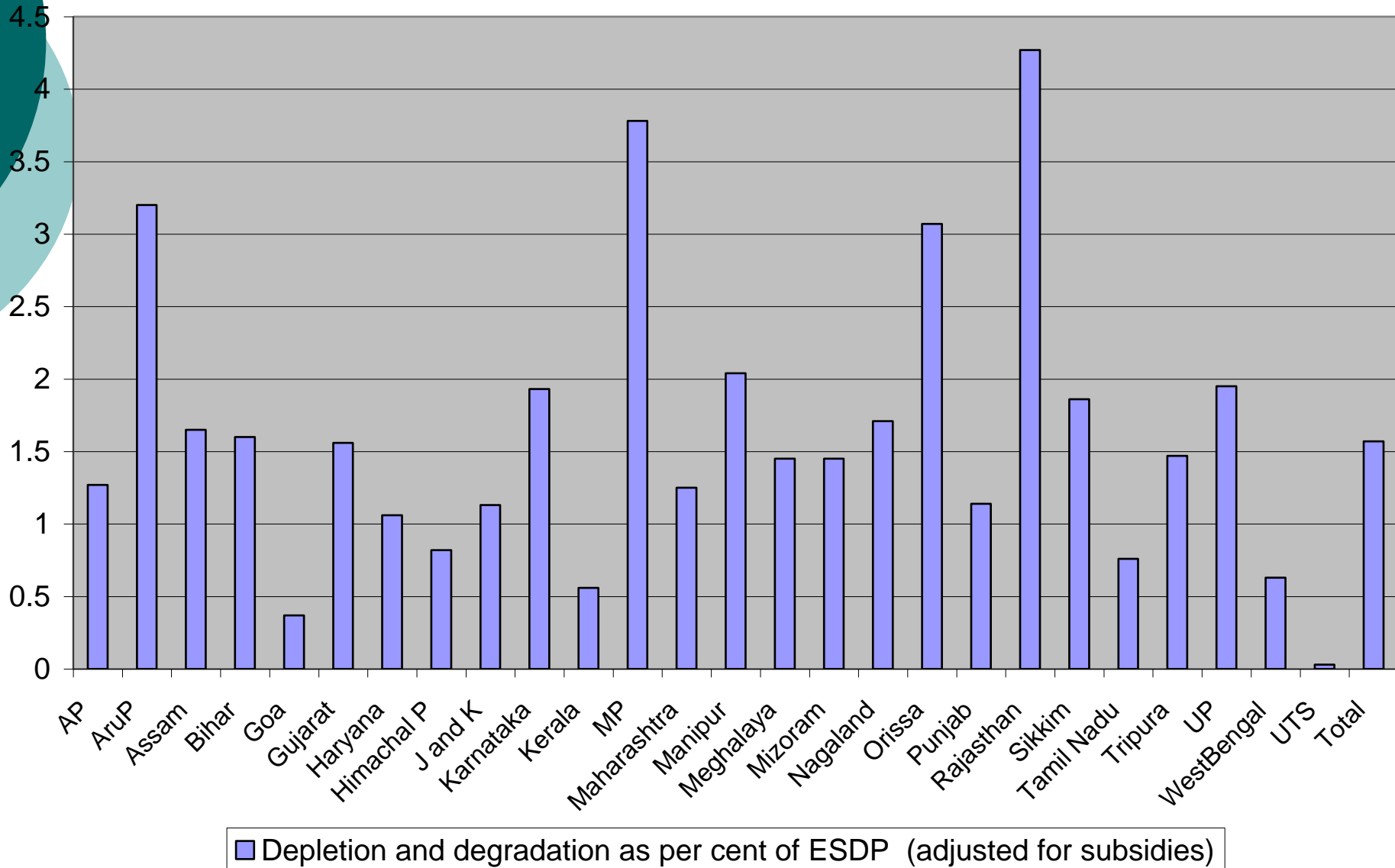
Conclusions

- Agriculture impose significant external costs on the environment in most of the states in the form of soil erosion and sedimentation of waterways.
- The external costs range from 0.3% – 4.5% of the NSDP
- Some of the states downstream face external costs due to unsustainable land use practices upstream
- If environmental externalities are taken into account, the contribution of agriculture to GDP is lower than what the estimates indicate.
- The results also indicate the proportion of NSDP that has to be set aside to maintain the environmental capital in tact.
- Need for correct agricultural policies – need of the day
- The policies need to be farsighted than short-sighted.

Thank You

Physical accounts for agricultural and Pasture Land

State	Agricultural Land (000 ha)			Pastureland (000 hectare)		
			(Change in 10 year period)			
	Opening stocks	Changes in quantity	Closing stock	Opening stocks	Changes in quantity	Closing stock
AP	10466	649	11115	1078	-134	944
ArP	150	14	164	44	-4	40
Assam	2706	28	2734	431	-34	397
Bihar	7162	275	7437	422	27	449
Goa	138	3	141	2	0	2
Gujarat	9583	-140	9443	852	1	853
Haryana	3474	52	3526	35	6	41
HP	573	-18	555	1246	340	1586
JK	730	18	748	197	1	198
Karnataka	10788	-378	10410	1238	877	2115
Kerala	2250	-44	2206	36	-21	15
MP	19542	-115	19427	2783	-345	2438
Maharasthra	18020	-384	17636	1467	100	1567
Manipur	140	0	140	24	0	24
Meghalaya	201	29	230	156	-1	155
Mizoram	65	29	94	7	47	54
Nagaland	204	96	300	129	-4	125
Orissa	6304	-475	5829	1520	-595	925
Punjab	4139	125	4264	8	9	17
Rajasthan	16938	-1073	15865	1789	-68	1721
Sikkim	95	0	95	74	0	74
TN	5813	-510	5303	352	26	378
Tripura	268	12	280	27	0	27
UP	17259	353	17612	857	7	864
WB	5494	-77	5417	68	-7	61
India	142645	-1544	141101	14877	-614	14263

State	Land degradation (000 ha) (as per the latest estimate)						
	Gl and R	US	WL/ML	S/A	DP and DG	SC	Total
AP	69.27	2025.70	103.50	60.33	70.93	1.38	2331.11
ArP	0.00	332.68	4.15	0.00	213.50	308.81	859.14
Assam	0.00	84.37	163.36	0.00	221.79	839.15	1308.66
Bihar	55.92	468.99	119.89	0.05	16.50	4.55	665.89
Goa	0.00	29.28	4.10	0.00	0.25	0.00	33.63
Gujarat	101.30	2178.70	265.63	763.73	38.75	0.00	3348.10
Haryana	4.95	98.84	23.83	28.56	72.17	0.00	228.35
HP	12.19	205.65	1.57	0.14	427.82	0.00	647.36
JK	2.13	449.53	24.65	0.00	26.75	0.00	503.06
Karnatak	30.15	908.77	3.28	12.51	9.75	0.00	964.45
Kerala	0.00	35.79	13.60	0.00	0.40	0.00	49.79
MP	756.90	3697.80	5.17	16.28	30.24	0.00	4506.40
Maharash	170.00	3138.70	52.76	25.17	134.94	0.00	3521.56
Manipur	0.00	0.13	32.46	0.00	0.00	1201.4	1233.99
Meghalay	0.00	419.06	1.49	0.00	0.00	208.68	629.23
Mizoram	0.00	0.00	0.00	0.00	0.00	376.12	376.12
Nagaland	0.00	159.65	0.00	0.00	0.00	522.47	682.12
Orissa	18.58	835.87	37.91	5.15	1.34	11.53	910.38
Punjab	16.85	33.94	35.20	17.33	11.37	0.00	114.70
Rajasthan	495.30	2715.30	28.97	272.30	1220.8	0.00	4732.71
Sikkim	0.00	28.69	0.01	0.00	0.00	40.09	68.79
TN	0.00	107.31	0.00	0.00	0.00	0.00	107.31
Tripura	22.61	769.79	41.58	247.97	16.89	0.05	1098.90
UP	280.70	549.90	498.14	581.19	44.64	0.00	1954.57
WB	17.19	124.52	193.15	13.13	38.50	0.00	386.49
India	2055.3	19401.4	1656.8	2047.7	2597.9	25703.8	27759.14

State	Soil erosion (million tones per year)				
	On-site impact				Off-site impact
	Soil erosion (MT/year)	N Loss	P Loss	K Loss	Water sedimentation (MT/year)
AP	275.9	0.106	0.239	3.684	7.989
ArP	4.0	0.002	0.003	0.053	13.068
Assam	71.3	0.027	0.062	0.953	12.463
Bihar	188.8	0.073	0.164	2.521	30.904
Goa	3.6	0.001	0.003	0.049	0.009
Gujarat	252.7	0.097	0.219	3.373	4.064
Haryana	91.6	0.035	0.079	1.223	5.825
HP	15.1	0.006	0.013	0.202	3.445
JK	19.2	0.007	0.017	0.257	6.438
Karnataka	284.4	0.110	0.247	3.798	15.611
Kerala	59.3	0.023	0.051	0.792	0.612
MP	515.2	0.198	0.447	6.879	252.455
Maharash	475.1	0.183	0.412	6.343	75.786
Manipur	3.7	0.001	0.003	0.049	0.011
Meghalaya	5.3	0.002	0.005	0.071	0.562
Mizoram	1.7	0.001	0.001	0.023	0.008
Nagaland	5.4	0.002	0.005	0.072	0.702
Orissa	166.2	0.064	0.144	2.219	8.556
Punjab	109.1	0.042	0.095	1.457	5.277
Rajasthan	446.6	0.172	0.387	5.962	163.952
Sikkim	2.5	0.001	0.002	0.033	0.126
TN	153.3	0.059	0.133	2.046	0.501
Tripura	7.1	0.003	0.006	0.094	0.002
UP	455.1	0.175	0.395	6.075	120.951
WB	144.9	0.056	0.126	1.934	12.397
India	3761.0	1.448	3.261	50.213	741.713

Monetary Accounts (in Rs Millions)

| | Changes in quantity | | | | Changes in quantity | | | Changes in quality of land | | | | | | | Replacement cost per annum of | | | | For 20 years | Per annum |
| | Agricultural Land (rupees million) | | | | Pastureland (rupees million) | | | Productivity losses due to land degradation (20- year period) | | | | | | | | | | | | |
State	Opening Stocks	Changes in quantity	Revaluation	Closing stock	Opening Stocks	Changes in quantity	Closing stock	G and R	U/S	WL and ML	S/A	DP and DG	SC	Total	N	P	K	Total	Cost of reclamation	Cost of sediment removal
Andhra Pradesh	212875.84	13200.50	7163.59	233239.92	5392.88	-670.36	4722.52	1431.26	41855.01	855.42	934.84	1465.53	28.51	46570.58	513.18	734.54	16424.03	17671.75	6070.426	974.61
Arunachal Pradesh	59.74	5.58	2.07	67.39	4.31	-0.39	3.92	0.00	73.62	0.67	0.00	86.38	124.95	285.62	7.35	10.53	235.39	253.27	4359.495	1594.25
Assam	17172.86	177.69	549.78	17900.33	672.74	-53.07	619.67	0.00	297.50	421.25	0.00	1429.79	5409.80	7558.34	132.68	189.92	4246.46	4569.06	4881.998	1520.53
Bihar	114865.11	4410.49	3779.44	123055.03	1664.65	106.51	1771.15	911.06	4179.17	781.29	0.62	268.77	74.05	6214.97	351.17	502.65	11239.15	12092.97	4134.878	3770.32
Goa	40.31	0.88	1.30	42.49	0.14	0.00	0.14	0.00	4.75	0.49	0.00	0.07	0.00	5.31	6.77	9.69	216.56	233.01	3399.979	1.05
Gujarat	134354.52	-1962.81	4195.04	136586.75	2937.96	3.45	2941.41	1442.74	16971.54	1513.24	8157.90	551.81	0.00	28637.24	469.88	672.56	15038.36	16180.81	7252.519	495.86
Haryana	5424.05	81.19	174.44	5679.69	13.44	2.30	15.74	7.85	85.74	15.12	33.98	114.46	0.00	257.15	170.34	243.82	5451.66	5865.82	3626.307	710.67
Himanchal Pradesh	5842.55	-183.54	179.31	5838.33	3124.80	852.67	3977.47	126.26	1165.06	6.50	1.06	4431.32	0.00	5730.20	28.10	40.21	899.19	967.51	4113.342	420.26
Jammu and Kashmir	1816.27	44.78	58.97	1920.02	120.55	0.61	121.17	5.37	621.42	24.92	0.00	67.61	0.00	719.33	35.79	51.23	1145.57	1232.60	3945.609	785.47
Karnataka	196136.37	-6872.41	5997.13	195261.09	5535.97	3921.69	9457.66	556.84	9180.03	24.20	173.30	180.00	0.00	10114.37	528.97	757.13	16929.34	18215.44	4481.909	1904.52
Kerala	20080.19	-392.68	623.83	20311.34	79.02	-46.10	32.93	0.00	177.48	49.32	0.00	3.62	0.00	230.42	110.32	157.91	3530.87	3799.10	3418.762	74.61
Madhya Pradesh	422853.76	-2488.39	13319.9	433685.30	14811.21	-1836.10	12975.11	16637.44	44456.74	45.47	268.40	664.79	0.00	62072.85	958.20	1371.52	30666.77	32996.49	8598.852	30799.46
Maharashtra	459373.04	-9789.08	14245.8	463829.74	9198.08	627.00	9825.07	4402.37	44456.33	546.48	488.78	3494.44	0.00	53388.40	883.57	1264.70	28278.33	30426.61	7454.141	9245.83
Manipur	54.27	0.00	1.72	55.99	2.29	0.00	2.29	0.00	0.03	5.11	0.00	0.00	473.13	478.28	6.86	9.83	219.70	236.39	4795.205	1.29
Meghalaya	76.32	11.01	2.77	90.10	14.57	-0.09	14.48	0.00	88.41	0.23	0.00	0.00	80.49	169.13	9.86	14.11	315.42	339.39	4092.263	68.58
Mizoram	13.39	5.98	0.61	19.98	0.35	2.38	2.74	0.00	0.00	0.00	0.00	0.00	78.73	78.73	3.19	4.56	102.00	109.75	3798.066	1.01
Nagaland	82.34	38.75	3.84	124.92	12.81	-0.40	12.41	0.00	35.80	0.00	0.00	0.00	214.21	250.02	10.00	14.32	320.13	344.45	4153.742	85.64
Orissa	57013.50	-4295.91	1670.44	54388.03	3381.13	-1323.53	2057.59	170.70	4200.23	139.32	35.48	12.34	105.91	4663.98	309.10	442.43	9892.71	10644.25	4419.058	1043.81
Punjab	64711.30	1954.32	2112.40	68778.02	30.76	34.61	65.37	267.62	294.86	223.63	206.42	180.60	0.00	1173.12	202.95	290.49	6495.23	6988.66	3494.202	643.79
Rajasthan	256766.90	-16265.85	7620.66	248121.71	6670.27	-253.54	6416.73	7627.32	22870.08	178.42	3144.94	18800.20	0.00	52620.97	830.52	1188.76	26580.38	28599.66	8861.9	20002.11
Sikkim	13.87	0.00	0.44	14.31	2.66	0.00	2.66	0.00	2.33	0.00	0.00	0.00	5.95	8.28	4.66	6.67	149.08	160.41	3440.84	15.43
Tamil Nadu	89062.11	-7813.81	2574.48	83822.79	1326.45	97.98	1424.43	0.00	913.49	0.00	0.00	0.00	0.00	913.49	285.03	407.97	9122.19	9815.20	3485.618	61.16
Tripura	203.52	9.11	6.74	219.38	5.04	0.00	5.04	17.44	324.81	12.83	143.47	13.03	0.04	511.63	13.14	18.81	420.57	452.52	4638.179	0.23
Uttar Pradesh	695671.59	14228.64	22494.31	732394.53	8496.22	69.40	8565.61	11493.64	12315.31	8158.86	17848.21	1827.68	0.00	51643.71	846.26	1211.29	27084.11	29141.66	5632.761	14756.03
West Bengal	113059.54	-1584.56	3532.26	115007.24	344.18	-35.43	308.75	359.35	1423.74	1615.14	205.78	804.77	0.00	4408.78	269.39	385.59	8621.60	9276.57	3810.115	1512.49
Union Territories	190.99	-20.03	5.42	176.38	11.50	-3.61	7.88	1.74	1.91	1.34	3.97	0.07	0.00	9.03	7.01	10.04	224.41	241.45	3372.827	0.00
India	2867814.37	-17500.2	14894.5	2940630.8	63853.98	1495.98	931670.8	45459.00	205995.4	14619.25	31647.2	34397.31	6595.78	338713.9	6994.31	10011.26	223849.21	240854.79	123733	90489.00

Limitations

- We did not address/consider
- The extent of contamination of waterways by fertilizers and pesticides, which in turn lead to many health hazards.
- the net emissions of GHGs from agricultural activities.
- the loss of organic carbon due to agriculture .
- other aspects of erosion, such as its effects on the soil's physical structure, moisture capacity, organic matter content, soil fauna, and the levels of many other nutrients.

The replenishment of soil nutrients by itself is insufficient to restore original soil productivity.

- Artificial fertilizers are subject to volatilization and leaching, which makes them highly inefficient in replacing soil nutrients. These losses should be taken into account in the calculation of the replacement cost.
- We used an estimate of the cost of sedimentation in reservoirs. Given that rivers have a different hydrology from reservoirs and the sediment load is different, this estimate may be much lower than the actual.
- Agriculture has some positive externalities but not material in an Indian context.
- Our results should be viewed with an active consciousness of the limitations of the available data.
- The data required for agricultural accounting is site-specific.
- Site-specific estimates can be used at a more disaggregated level of accounts (such as the state and its districts) at a later stage.