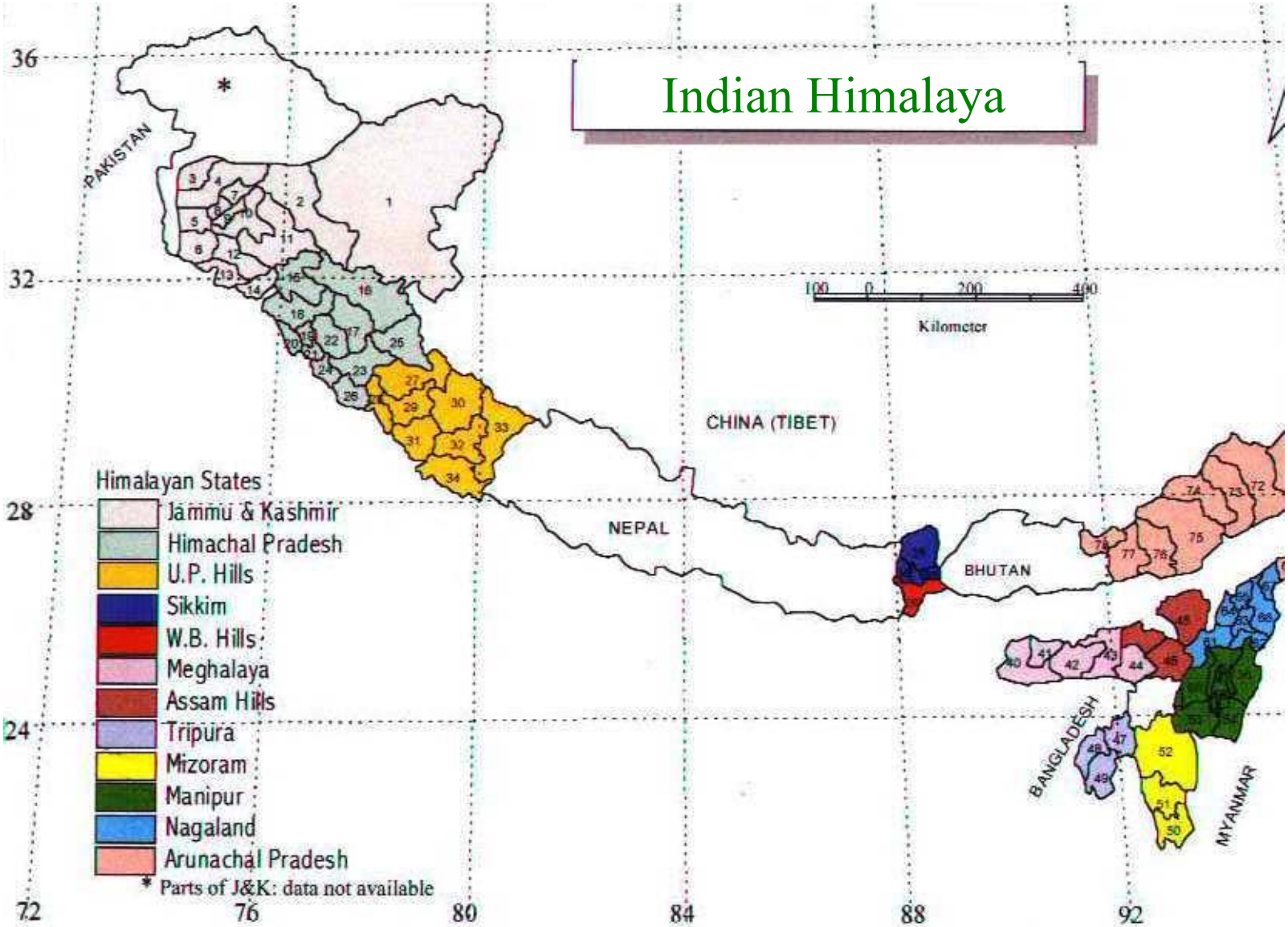
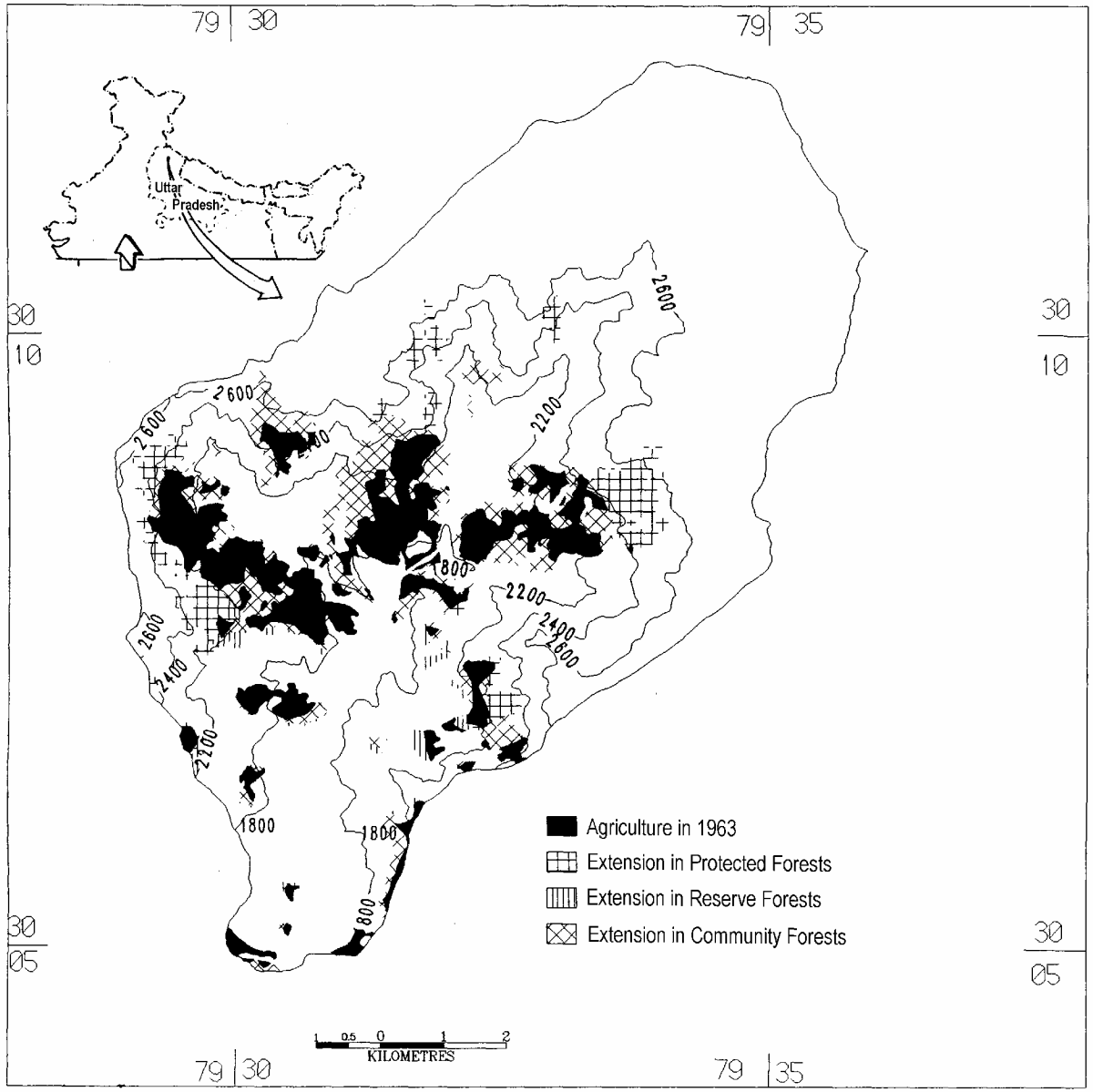
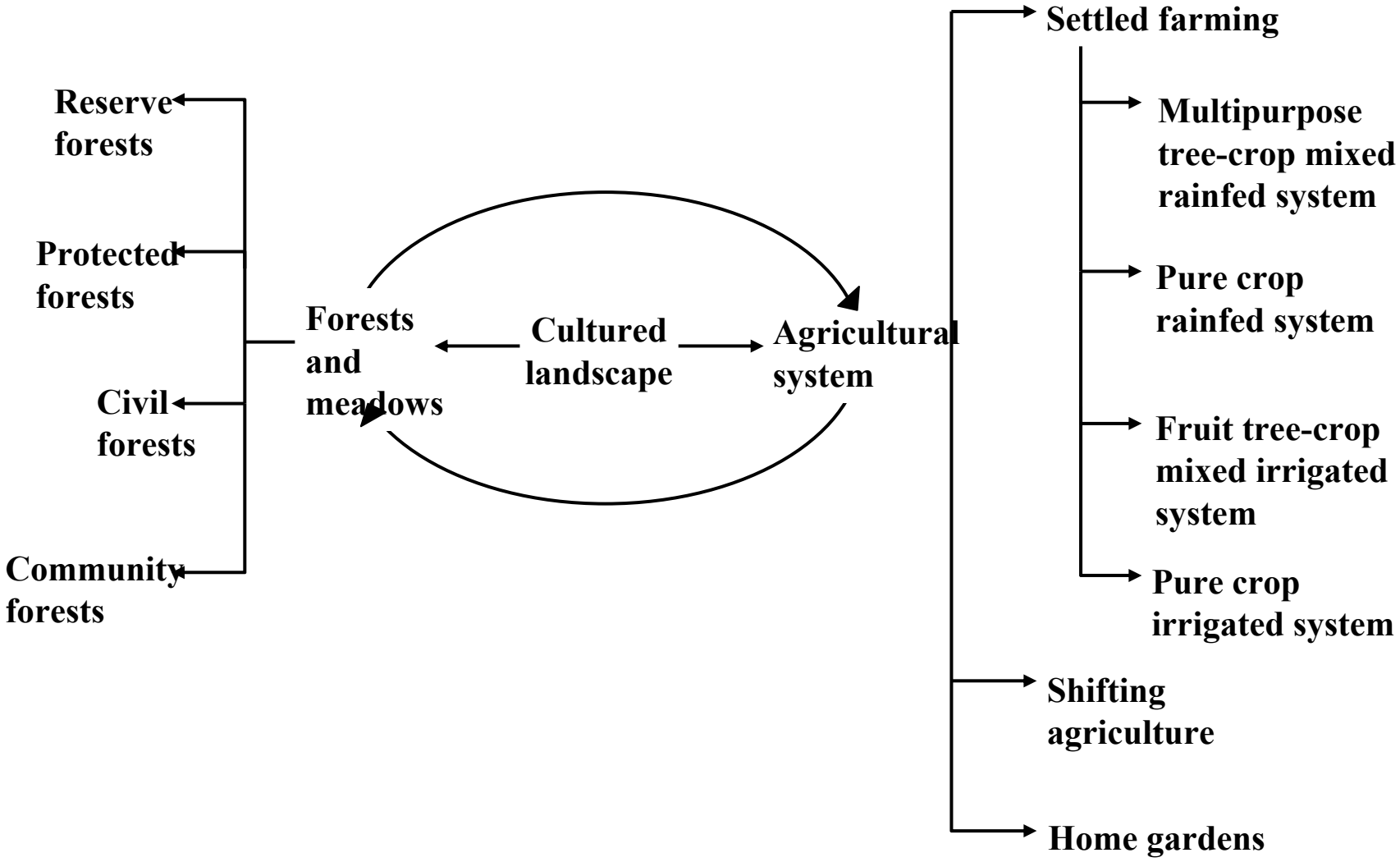
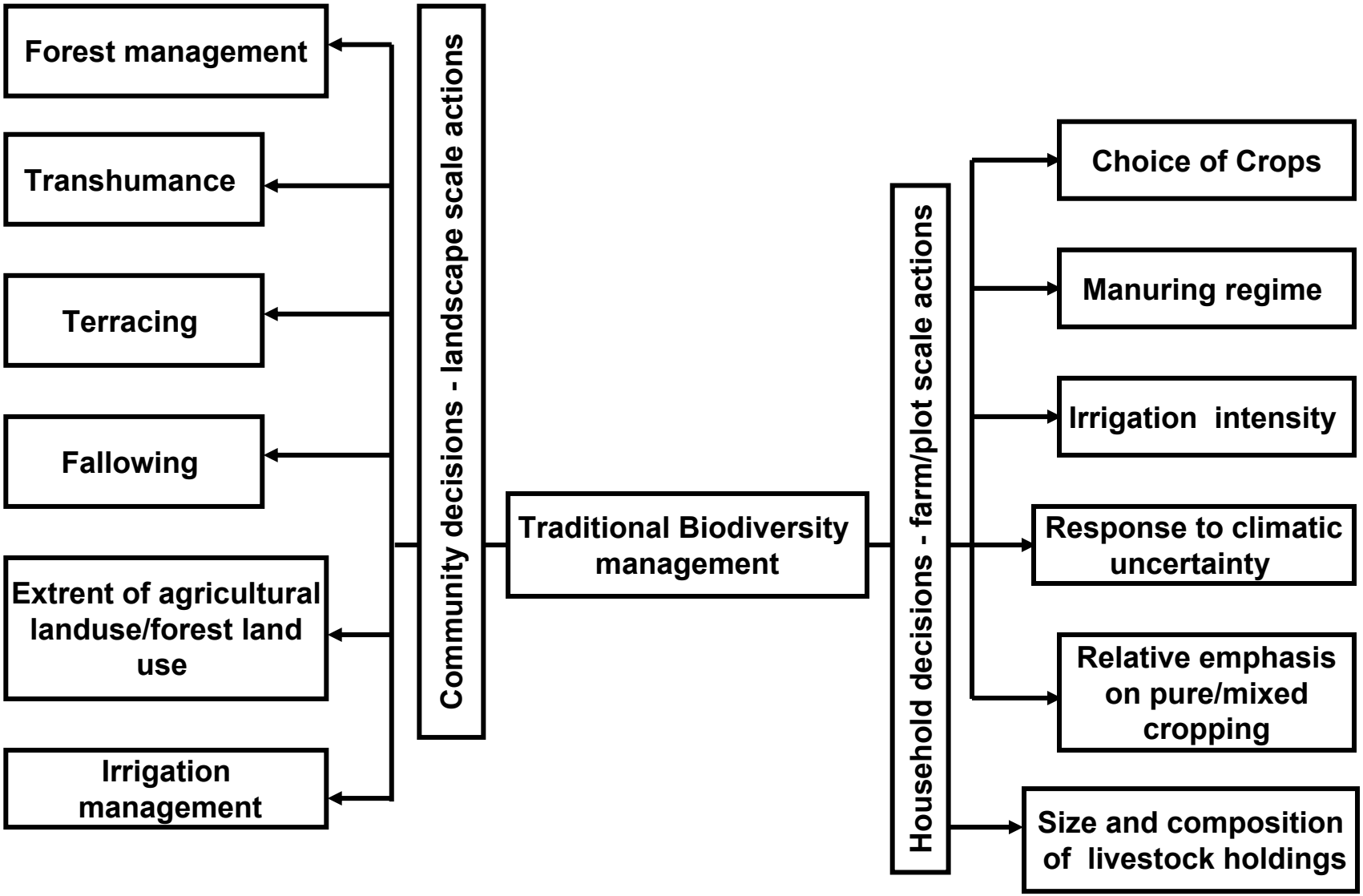
Changes in agricultural biodiversity: implications for sustainable livelihood in the Himalaya


Indian Himalaya
PAKISTAN
CHINA (TIBET)
NEPAL
BHUTAN
BANGLADESH
MYANMAR
100 0 200 400
Kilometer
Himalayan States
Jammu & Kashmir
Himachal Pradesh
U.P. Hills
Sikkim
W.B. Hills
Meghalaya
Assam Hills
Tripura
Mizoram
Manipur
Nagaland
Arunachal Pradesh
* Parts of J&K: data not available
36
32
28
24
72
76
80
84
88
92

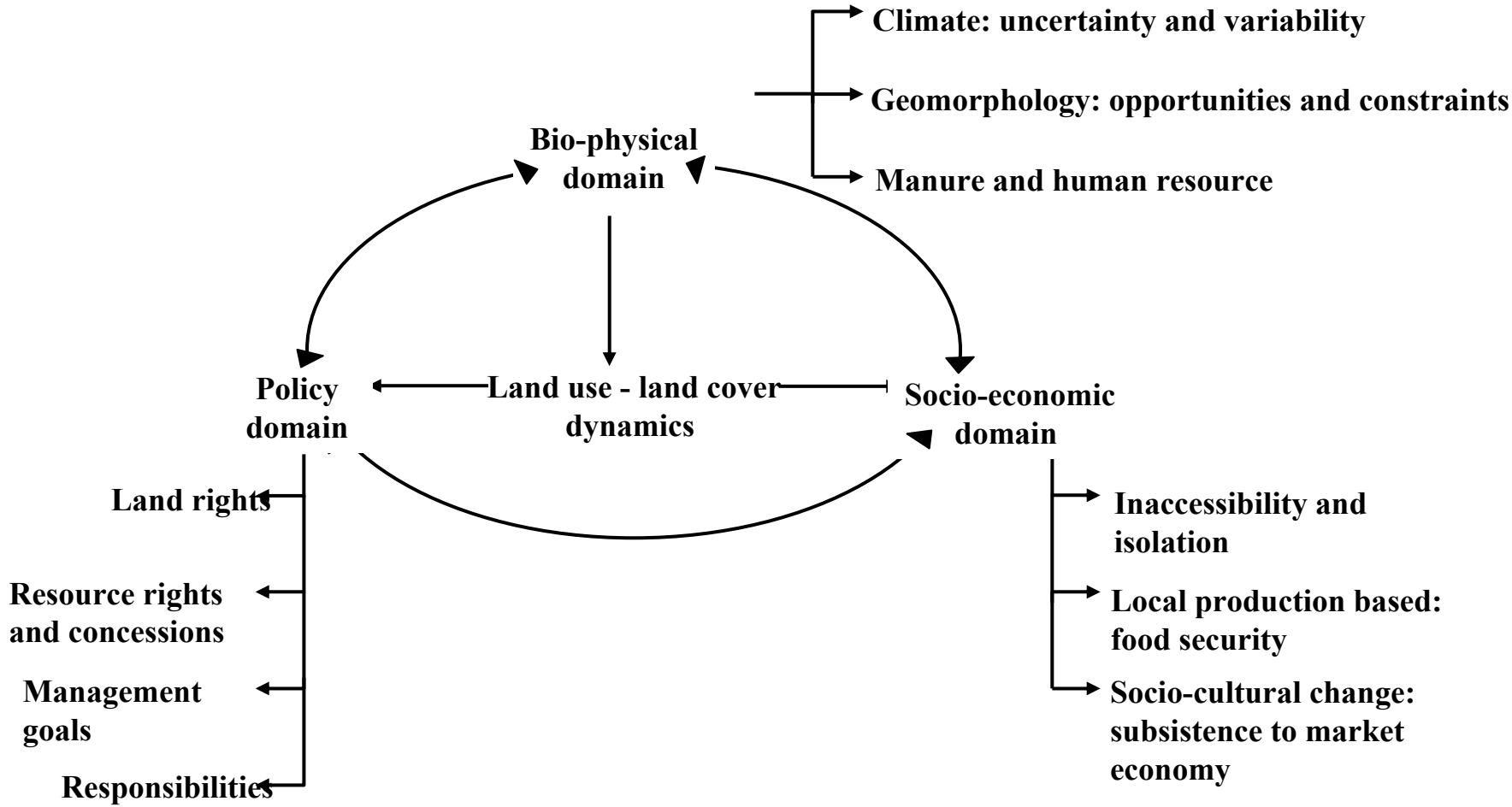

79 30
79 35
30 10
30 05
Uttar Pradesh
2600
2200
1800
2400
Agriculture in 1963
Extension in Protected Forests
Extension in Reserve Forests
Extension in Community Forests
1 0.5 0 1 2
KILOMETRES

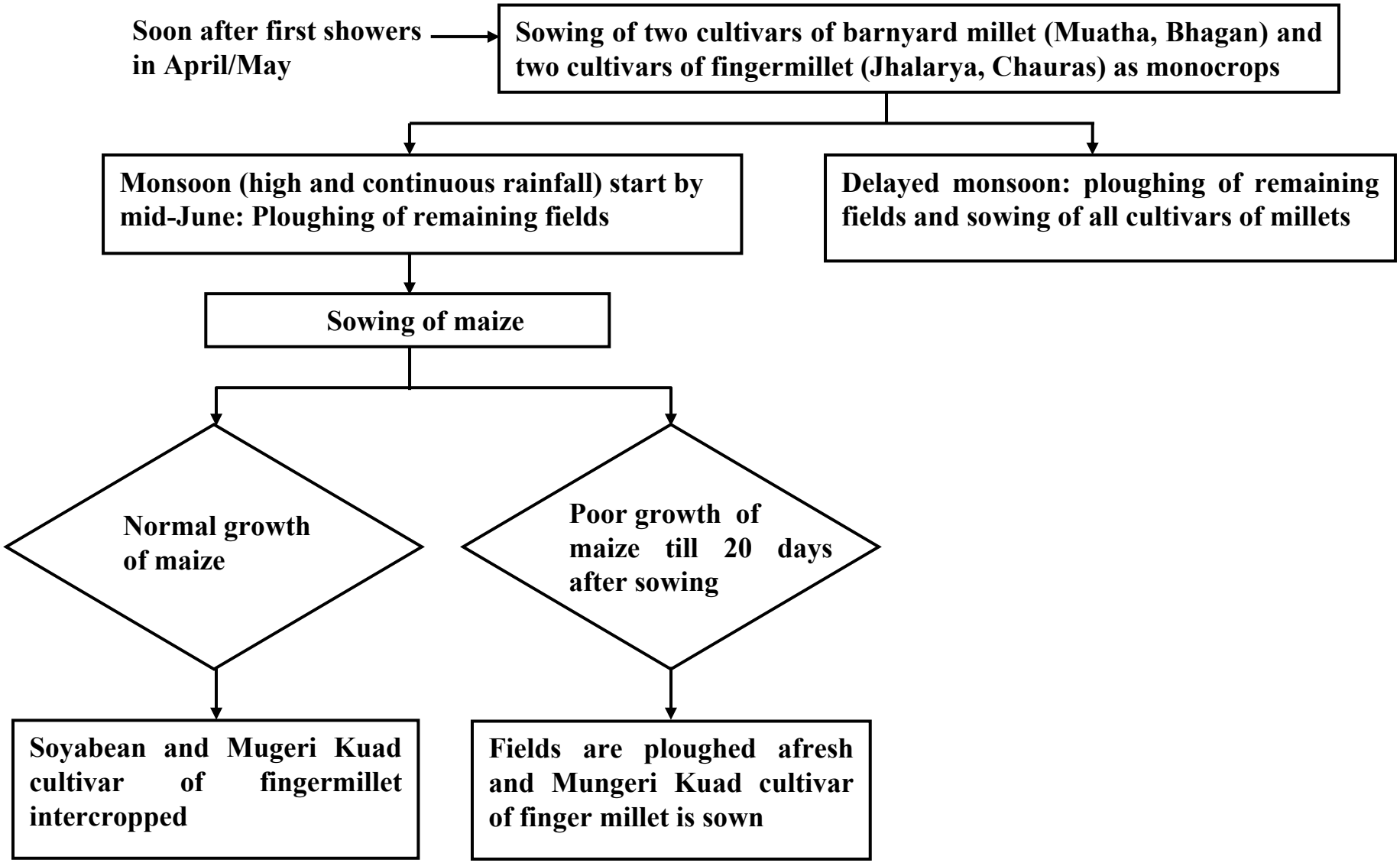


Ecosystem differentiation in the landscape



Spatial dimension of traditional biodiversity management in Central Himalaya.


Climate: uncertainty and variability
Geomorphology: opportunities and constraints
Manure and human resource
Bio-physical domain
Policy domain
Land use - land cover dynamics
Socio-economic domain
Land rights
Resource rights and concessions
Management goals
Responsibilities
Inaccessibility and isolation
Local production based: food security
Socio-cultural change: subsistence to market economy



Cropping pattern as determined by climatic conditions in a mid-altitude village

Crops	Near core zone and low altitude			Away from core zone and high altitude		
	% of total cropped area in 1995 (n = 117) (%)	Increased (+) decreased (-)/no change (o) of total cropped area between 1970 - 75 and 1995 (n = 46) (%)	Monetary Value (n=10) (US$/ha)	% of total cropped area in 1995 (n=42) (%)	Increased (+) decreased (-) /no change (o) of total area between 1970-75 and 1995 (n = 17) (%)	Monetary value (n=10) (US$/ha)
Food crops						
Amaranthus paniculatus	4.4	+36	289±31	-	0	-
Brassica campestris	0.6[a]	0	519±37[a]	3.1[b]	-	494±34[a]
Echinochloa frumentocea	0	-100	-	0	0	-
Eleusine coracana	0.6	-10	311±28	-	0	-
Fagopyrum esculentum	7.7[a]	0	337±21[a]	16.3[b]	-30	503±27[b]
Fagopyrum tataricum	8.2[a]	-19[a]	343±30[a]	2.3[b]	-76[b]	474±28[b]
Glycine max	0	-100	-	0	0	-
Hordeum himalayens	5.6[a]	-41[a]	235±s27[a]	8.1[a]	-60[b]	239±15[a]
Hordeum vulgare	4.0	-28[a]	247±24	0	-100[b]	-
Pennisetum typhoides	0	-100	-	0	0	-
Panicum miliaceum	0.6[a]	-82[a]	268±27[a]	2.5[b]	-79[a]	310±27[a]
Phaseolus lunetus	14.6[a]	+43[a]	549±62[a]	8.6[b]	+68[a]	626±63[a]
Phaseolus vulgaris	6.0[a]	+40[a]	906±27[a]	8.9[a]	+143[b]	969±82[a]
Pisum sativum (Var.2)	0.3[a]	-28[a]	547±55[a]	2.3[b]	-50[b]	647±44[a]
Solanum tuberosum	6.6[a]	+97[a]	805±81[a]	31.3[b]	+650[b]	1048±28[b]
Setaria italica	0	-100	-	0	0	-
Triticum aestivum	21.3	+13	265±29	0	-	-

Medicinal plants						
Allium humile	**0.9[a]**	**-7[a]**	**846±79[a]**	**2.3[b]**	**-7[a]**	**945±87[a]**
Allium stracheyi	**0.9[a]**	**-6[a]**	**502±48[a]**	**1.2[a]**	**-13[a]**	**560±87[a]**
Angelica glavacai	**-**	**-**	**-**	**0.3**	**+100**	**544±57**
Carum carvi	**-**	**-**	**-**	**0.3**	**+100**	**971±85**
Dactylorhiza hatagirea	**-**	**-**	**-**	**0.2**	**+100**	**786±80**
Megacarpaea polyandra	**-**	**-**	**-**	**0.2**	**+100**	**272±19**
Pleurosperum angelicoides	**-**	**-**	**-**	**0.2**	**+100**	**627±60**
Saussurea *costus*	**-**	**-**	**-**	**0.3**	**+100**	**690±68**

Soil loss from different crops grown on varied terrace slopes in the Pranmati watershed, Indian central Himalya.

Crop	Soil loss from terrace slope (t ha^{-1} yr^{-1})					
	Low(<2^0)		Medium (2-6^0)		High (6-10^0)	
	1993	1994	1993	1994	1993	1994
Eleusine coracana	0.658	0.089	1.199	0.386	6.037	0.525
Amaranthus paniculatus	0.517	0.372	1.462	0.437	13.435	1.475
Echinocloa frumentacea	0.536	0.093	1.213	0.310	7.578	0.652
Oryza sativa	0.300	0.334	2.950	0.429	8.122	1.050
Solanum tuberosum	0.606	0.327	7.653	1.812	64.400	3.758

Farmyard manure (FYM) input (t/ha/year), fodder yield (t/ha/year) and monetary return (Thousand Rs./ha: Rs. 34 = US$ 1 in 1994-95) across elevation zones in Pranmati watershed, India.

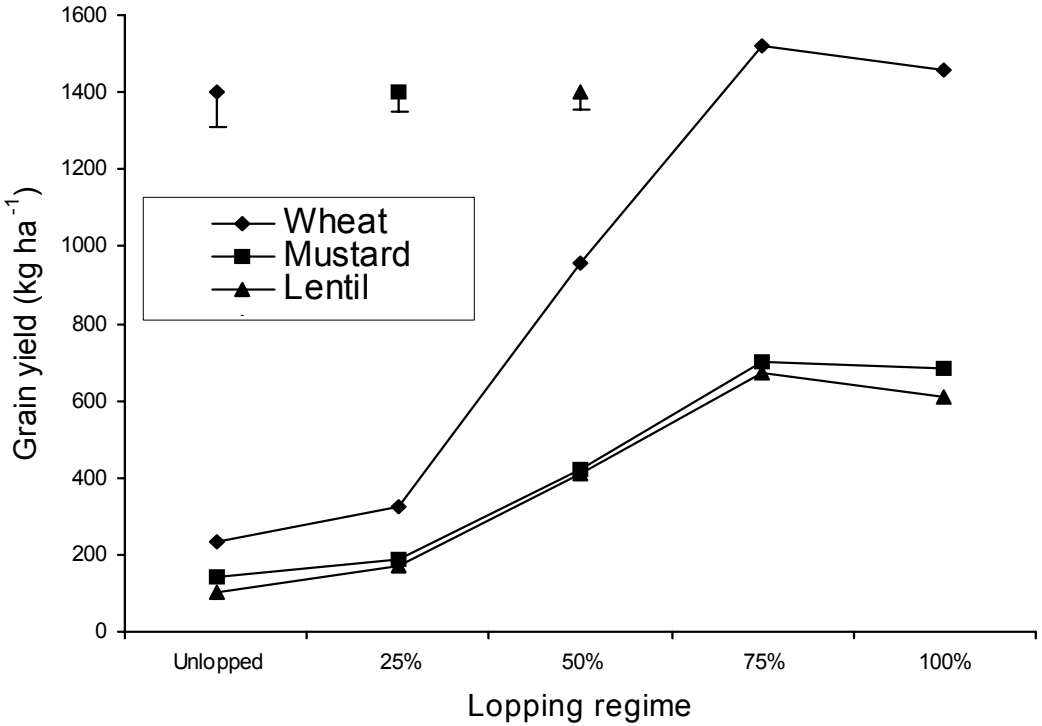
FYM/Fodder	1100 –1850 m		1850-2400m		2400-2600m	
	1963	1993	1963	1993	1963	1993
Manure input	15.0	16.5	18.3	27.4	16.8	32.4
Fodder yield	5.0	4.3	3.3	2.1	1.5	0.2
Monetary return	21.3	34.2	27.9	52.5	36.8	77.3

Important characteristics (mean ± standard deviation, n = 5) of oak-based and pine-based organic manure. Mean values of the two manure types are significantly (P<0.05) different if followed by a different superscript letter.

Characteristic	Manure type	
	Oak	Pine
Moisture (%)	226.21± 19.21[a]	303.50 20.50[b]
Carbon (%)	24.66 ± 0.58[a]	33.33 ± 0.58[b]
Nitrogen (%)	1.40 ± 0.03[a]	1.16 ± 0.03[b]
Cellulose (%)	12.33 ± 0.57[a]	17.00 ± 2.64[b]
Lignin (%)	14.01 ± 1.05[a]	17.33 ± 0.29[b]
Polyphenol (%)	0.32 ± 0.04[a]	0.37 ± 0.03[b]
C/N	17.68 ± 1.25[a]	28.73 ± 0.48[b]
Lignin / N	10.04 ± 0.71[a]	14.94 ± 0.25[b]
Polyphenol + Lignin/Nirtogen	10.26 ± 0.72[a]	15.26 ± 0.25[b]

Biomass production (mean ± SD, g m^{-2}) of wheat crop on a sandy soil treated with oak based and pine based manure (@ 10 t ha^{-1}). Two treatments are significantly ($P < 0.05$) different for all parameters.

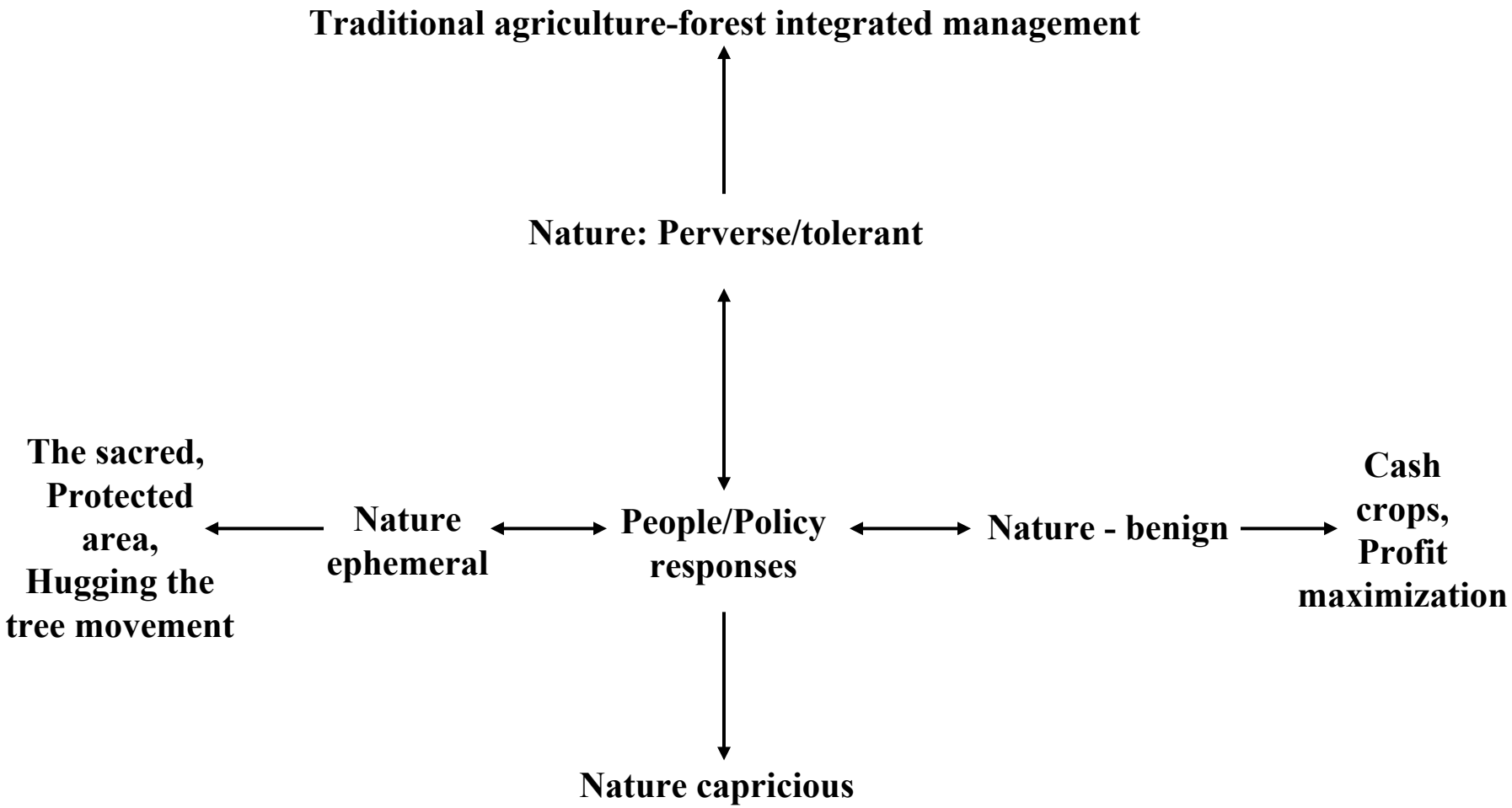
Component	Manure type	
	Oak based	Pine based
Grain	58.5 ± 3.8	46.7 ± 2.7
Straw	108.8 ± 12.1	81.7 ± 5.6
Roots	8.5 ± 0.6	7.3 ± 0.1
Total	175.8 ± 11.6	135.7 ± 9.8



Yield of winter season crops grown under unlopped and 25%, 50%, 75% and 100% lopping of agroforestry trees in village Banswara, India. LSD (P=0.05) between means of a crop grown under different lopping regimes are given as vertical lines.

Carbon sequestration rate (t ha^{-1} yr^{-1}) in soil and vegetation after rehabilitation in a low altitude village (Banswara, Chamoli) and a high altitude village (Khaljhuni, Almora) villages in Indian Central Himalaya.

Characteristics	Carbon sequestration	
	Banswara	Khaljhuni
Soil (0-15 cm)	2.2	3.4
Tree bole/bamboo culm	0.9	4.3
Total	3.1	7.7


Traditional agriculture-forest integrated management
Nature: Perverse/tolerant
The sacred, Protected area, Hugging the tree movement
Nature ephemeral
People/Policy responses
Nature - benign
Cash crops, Profit maximization
Nature capricious