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Precision Farming Practices in Cold Desert: From Subsistence to Cash Crop Economy

Rajan Bawa

Former Professor Emeritus (UGC) Presently Professor (Agroforestry)
College of Horticulture and Forestry, Central Agricultural University
Pasighat – 791 102 Arunachal Pradesh
E-mail: rbawauhf@yahoo.co.in

Abstract—*Local people in the cold desert areas have acquired rich knowledge concerning their farm soils, crops, livestock and environment. This indigenous knowledge, develop and adapted as a result of years of practical experience, continues to be the process of evolution for the urge of better and sustainable livelihood. Only such traditional precision farming practices developed from the meagre resources available and mechanisms that were inherent in the natural system and modified by the inhabitants led to their coexistence till date even in such hostile conditions.*

The cold deserts are characterized by short growing season and hostile climate coupled with weak market infrastructures, high emigration, predominance of female managed households, money order economics, poor linkages between formal and informal sectors and low levels of social and political articulations; but still the age old experience of local farming community made them shift from traditional crop growing to cash crops, hence refuting all the misconceptions.

Between conventional agriculture, alternative agriculture, organic agriculture, industrial agriculture, eco-agriculture, sharp distinctions are drawn among crop production systems. Since differences in practices and philosophy can be a source of controversy and heated discussion, but there are important underlying similarities among farming systems of all types and labels

The ecology of agro ecosystem of traditional crops and present day cash crops in cold desert areas with respect to nutrient and biomass cycling, economic gains are discussed in detail with reference to benefits and losses for long term sustainability.

1. INTRODUCTION

India is a vast country with diverse physiographic characteristics. The cold deserts in India cover approximately 74,809 km^2 and because of their physiographic processes going on in these regions. The cold deserts in Himachal Pradesh are restricted to the districts of Lahaul and Spiti, parts of Kinnaur (Sumdo side) and Pir Panjal in Chamba districts.

These areas have very difficult terrains with ice fields, perpetual snow covered peaks and hostile climate. The cold deserts in Himachal Pradesh cover nearly 35 per cent of the State's geographical area and comprises of two different valleys, viz., Lahaul and Spiti. Physically Lahaul is narrow, too steep and studded with some patches of natural conifers, *Betula* and *Rhododendron* species. While on the other hand, Spiti is completely rugged without any verdure worth the name with broad sandy valleys and high peeks (6000 m amsl).

The geology of the area comprises of genesis and schistone (Rohtang), slate, quartzite, phyllites, sandstone (Batal), dolomite, shales, limestone, fossiliferous limestone, calcareous shales with rich fossils.

In broader sense, the climate can be categorized into spring, autumn, summer and winter season. Spring [Short Lives], Autumn [One month], Summers [3 to 4 months] and Long Freezing Winters [>5 Months with -10˚ to -30˚C]. Large Diurnal Temperature Variations. Strong Winds [Especially During Summers]. Excessive Dust Storms in Summers. Atmospheric Temperature : [+]30º to [-]30º C. More of IR and UV Radiations.

The cold deserts are known for High mountain peaks, Glaciers, Fresh water bodies, Salt water lakes, Alpine pastures, Rich floral and faunal diversity, Sand dunes, Sparse vegetation cover and Restricted arable lands.

Importance of Cold Deserts can be categorized as Upland Downstream Linkages and providing Ecosystem Services

2. UPLAND DOWNSTREAM LINKAGES AND ECOSYSTEM SERVICES

- UPLAND
  - Glaciers
  - Fresh water bodies
  - Monitor monsoons
  - Charge water table
  - Wealth of M&AP
  - Rare fauna
  - Home to rare migratory birds
- DOWNSTREAM
  - Seasons
  - Regulate water supply

- Agriculture
- Horticulture
- Alluvial deposits
- Breeding programmes
- Food security
- Health security
- Regulate monsoons
- Wind currents
- Power
- Industry
- Tourism
- And an endless list

World Land Surface

- Land Surface = 14.4 billion ha
- Dry Lands = 5.2 billion ha
- Degraded = 3.6 billion ha
- Non degraded = 1.6 billion ha

Cold Deserts Known for

- High mountain peaks
- Glaciers
- Fresh water bodies
- Salt water lakes
- Alpine pastures
- Rich floral and faunal diversity
- Sand dunes
- Sparse vegetation cover
- Restricted arable lands

Socioeconomic Factors of Vulnerability to Drivers of Change in Cold Deserts

- Disproportionate poverty rates
- High prevalence of food insecurity and nutritional insecurity
- High dependency on natural resources
- Marginalization and limited livelihood diversity

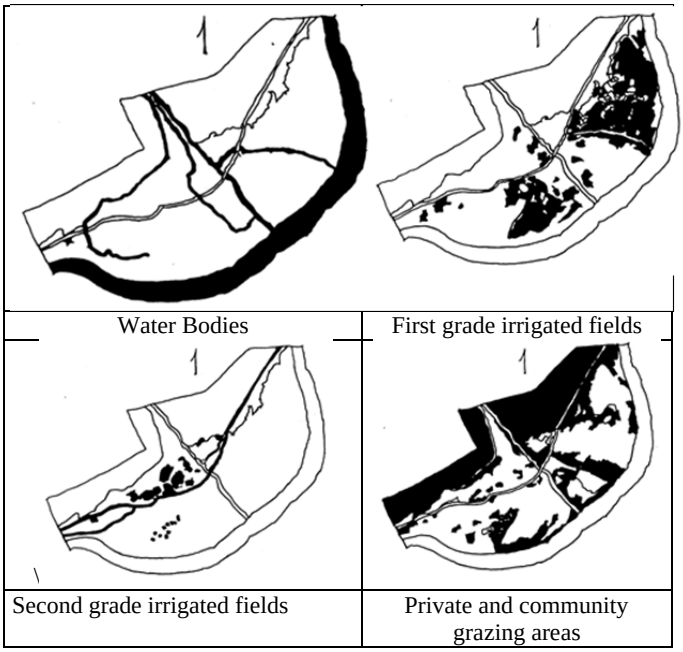
Livelihood Options In Cold Deserts

- Agriculture
  - Traditional crops [wheat, barley, potato, pseudo cereals, few vegetables, medicinal plants, wood work, woolens, daily wages employees, etc
  - Now cash crops + off season vegetables, floriculture, potato, wheat, barley, medicinal plants, horticulture, small scale industry
- Pastoral
  - Migratory grazers, local grazers, permanent pastoral
- Ecotourism=Summer season only

Natural Vegetation

- Quite sparce
- Trees : Junipers, Rhododendrons, Betula, Poplars and Willows
- Shrubs: Hippophae, Myricaria, Ephedra, Rosa, Artemesia, Astragalus, Caragana, Salix
- Herbs : Thymus, Medicago, Trifolium, Alium, Anemone, Potentila, Epilobium, Verbena, Aconite, Delphenium, Aquilegia, Geranium, Polygonum, etc

Landuse Pattern Village Poh - Spiti



Cropping Preference

(Average of 4 years)

Sr No	Crop	Village Poh (Spiti)	Village Goshal (Lahaul)
1	Wheat	19.01	7.88
2	Barley	16.16	2.67
3	Potato	3.38	27.24
4	Peas	22.80	61.68
5	Apple	17.18	Plantation done in 2002

Abiotic Factors Responsible for Extreme Xeric Conditions in Cold Deserts

Short Growing Season
Long Freezing Winters

Large Seasonal and Daily Diurnal Temperatures
Precipitation Mostly in Winters [Snow]
Soil Moisture Frozen During Early Spring
Low Rh During Growing Season
Thin Air [Low O2 and CO2]
Coarse, Highly Porous Immature Soils
Heavy Influx of IR and UV Radiations

Ecophysiological Reasons For Poor Plant Growth in Cold Deserts

Short Growing Season
Deformed Canopy
Leaf Injury
Restricted Photosynthesis
Increased Respiration Losses
Less of Radial Growth
Late Bud Flushing

Weak Photosynthesis: Ecophysiological Consequences-Low Carbon Fixation

Deficiency of organic matter

- Reduced growth = Resultant effect on plant parts
- Shoots + leaves = Reduction in photosynthesis = negative feed back
- Stem diameter = Smaller storage capacity for water, organic reserves, poor transportation
- Roots = Deficient mineral and nutrition supply
- Seeds = Restricted germination

Biomass production of major crops [average values]

(Min-Max values in kg/ha-dry weight/fresh

Crop	Total	Grains/Pods	Above ground / Straw	Below ground / Tubers
Wheat	45.00-47.40	14.780-15.60	26.60-27.90	3.70-3.90
Barley	47.80-52.30	15.40-16.80	28.60-32.20	3.50-3.70
Potato	21.41-24.95	--	0.48-0.60	20.90-24.44
Peas	13.82-19.78	10.40-15.60	0.48-0.52	0.26-0.31

Nutrients harvested and left in the field of the total uptake in traditional and cash crop (%)

Sr No	Nutrient	Crop			
		Wheat		Peas	
		Harvested	Left	Harvested	Left
1	N	89.58	13.71	97.99	2.01
2	P	86.29	14.02	98.64	1.36
3	K	85.989	11.04	99.64	0.36
4	Na	88.96	10.39	98.76	1.24
5	Ca	89.61		98.96	1.04

Photosynthesis and related studies

Sr No	Crop	Photosynthesis	Transpiration	WUE
1	Wheat	12.79	3.74	0.0034
2	Barley	12.51	3.59	0.0035
3	Potato	14.96	3.91	0.0038
4	Peas	9.96	3.54	0.0028
5	Grasses	25.35	2.68	0.0095
6	Herbs and shrubs	12.14	7.54	0.0027
7	Trees	12.97	1.86	0.0106

Harvest Index

Sr No	Crop	Village Dhankar	Village Poh	Village Goshal	Village Thingrit
1	Wheat	35.59	35.27	35.86	36.19
2	Barley	35.29	33.75	36.44	34.29
3	Potato	98.17	97.52	97.97	97.44
4	Peas	97.47	96.46	96.87	96.69

Cash Crop Economy in Spiti Valley

- Village Nako = Malling
- Total Houses = 175 [Nako = 115 + Malling = 60]
- Total Cropped area under peas = 700 bigahs
- Truckload of peas = 180
- Bags per truck = 125
- Peas / bag = 45-48 kg
- Rate of peas = Rs 35 to 40 / kg

Other Cold Desert Mountain Implications

- Mountains, in general, are considered highly vulnerable to climate change
- Climate change is threatening sustainable development, especially poverty alleviation
- Serious impacts in future due to the likelihood of frequent occurrences of extreme events
- The economic development prospects are facing increasing risks.

Cold Desert Gender Issues and Climate Change

Through influence on

- Natural resources and every aspect of health, food production, economic development and our general wellbeing
- Women have to play different roles in ensuring their livelihoods, their lives may be affected differently and they may play different roles in adapting to the changes

We Should Aim to Learn

- How women and men may be affected
- What do they do to respond to those stresses
- How can we tap women knowledge and capacities to support adaptation strategies
- Vulnerability in different ways
- Adapting to their changing environment
- Not to overlook women's role and capacities
- Tap their knowledge and skills to make those strategies efficient and sustainable.

Management Objectives

- Arrest and reverse the ongoing degradation of the valley ecosystem
- Improve the living conditions of the rural poor
- Management of the natural resources in a sustainable manner
- Increase productivity of the land
- Soil and water conservation
- Involving people in planning, implementation, management and monitoring activities
- Improvement in socioeconomic conditions of disadvantaged group

Special Emphasis Should Be On

- Change in irrigated area and cropping patterns and intensity
- Adoption of improved seeds, management practices and crop inputs/tools
- Establishment and maintenance of orchards and homestead gardens
- Use and effectiveness of Natural Breeding Centers and replacement of unserviceable cattle and bulls
- Change in livestock production systems
- Changes in livestock population and improvement in animal health
- Change in labour requirement and employment opportunities
- Operation and maintenance of minor irrigation systems
- Sustainability of crop / livestock production systems
- Enhance income of different farm household.

Blending Natural

And

Manmade Ecosystems

With

Enhanced Sustainable Ecological Services

For

Higher Economic Returns

As

We Have Only One Earth

To

Take Care