POLICY PAPER

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MANAGING SLOPING LANDS: STATUS, CONSTRAINTS, OPPORTUNITIES AND STRATEGIES

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SLOPING LANDS AT A GLANCE

Sloping lands/uplands/mountains cover 32 million km^2, which is 22 percent of the world's land surface. Asia alone hosts more than one-third of the world's mountains, including peak. However, almost half of the world's highland peaks are at less than 1000 m and overall, only 10 percent of mountains are higher than 3500 m (FAO, 2015). Uplands of India are located in the Himalayas, Western Ghats, Eastern Ghats and Vindhya Satpura Hills (Ministry of Agriculture - MOA, 1996). Out of 328 million ha of geographic area of India, about 93 million ha is mountainous. A major part of uplands, *i.e.*, 51.43 million ha lies in the Himalayan region (Dhandapani and Rath, 2004).

Mountains are home to about 915 million people, representing 13 percent of global population. In Hindu Kush Himalayan (HKH) Region which covers eight countries, India has the second highest population density of 73 persons per km^2 (Pratap, 1998). A study found that the number of people residing in vulnerable mountains had increased 30 percent from 2000 to 2012, while the mountain population itself had increased just 16 percent (FAO, 2015). While the global average of food insecure people in developing countries is one in eight, almost half of those who live in rural mountain areas of developing countries are vulnerable to hunger and face poverty and malnutrition. Most of the sloping lands of Himalayas are rainfed and the need of the farmers of the region revolves around production of food, fodder, fruit and timber throughout the year from same unit of land they own.

CONSTRAINTS IN SLOPING LANDS

- According to the Intergovernmental Panel on Climate Change (IPCC) report, temperatures are predicted to increase further in most mountainous areas, making it very likely that in near future, disasters and extreme events will affect mountains even more. This change would increase the vulnerability of mountain people in the long run and may push them to continue to out migrate or to deplete natural resources of mountains to survive (FAO, 2015).

- Singh *et al.* (1992) reported soil erosion varying from 5 Mg $ha^{-1}yr^{-1}$ to over 80 Mg $ha^{-1}yr^{-1}$ in Shivalik hills. Yadav and Sidhu (2010) reported erosion rates from 0.08 to 683.10 Mg $ha^{-1}yr^{-1}$ in Himachal Pradesh. This renders sloping lands less fertile.

- Consultative Group on International Agricultural Research (CGIAR, 1997) reported vulnerability and fragility of mountains, poverty of mountain inhabitants and overuse/ misuse of mountains for agriculture production as the three common concerns for which sloping lands require attention.

- Another constraint of sloping lands is less per capita agricultural lands. In Indian Himalayas, per capita available agricultural lands is only 0.293 ha (Pratap, 1998). NAAS (2011) reported that per capita availability of net cultivable land in India is less than 0.13 ha, which is quite less to sustain the family and hence poverty which intern leads to more exploitation of forest lands and hence degradation of natural resources.

- There is evidence that population growth supported by relevant technological and institutional tools can result in better conservation of sloping uplands (Tiffin *et al.*, 1994). Thus technological and financial support to the farmers of the sloping lands can improve the resource conservation and socio-economic upliftment of these farmers.

- Government of India started many schemes/programme for sloping lands directly or indirectly. The integrated watershed management programme has not made desired impact in terms of replicability of pilot projects despite the huge investment of public funds during the last two decades and only 35 % of the projects performed better than average (NAAS, 2011). The reasons for such failure were:

  a) Greater reliance on crops – lack of appreciation of farming system perspective and production system diversification and livelihood activities.

  b) Poor management of developed natural resources especially water for productive purpose.

  c) Water harvesting structures are the best way out for sustainable agriculture in rainfed areas in hilly region. However, after surveying about 102 Water Harvesting Structures (WHS) in Haryana, 72 in Punjab and 120 in Himachal

Pradesh (Arya and Samra, 2001) concluded that some of the water harvesting structures have not served the purpose because of technical difficulties by implementing agencies besides the social conflicts among the beneficiaries and village level institutions.

Another constraint in watershed development is that it requires secured property rights as it involves long term investments which can be successfully made only if the entire community to be benefited is mobilized to support collective action, which is a difficult task.

OPPORTUNITIES IN SLOPING LANDS

- In India, most of the sloping lands/ mountain (except cold deserts) areas receive more than 1000 mm of rainfall which is quite sufficient for crop production and water storage.
- Sloping lands have a unique opportunity as the water stored can be utilized without using energy as it can be conveyed through gravitational flow. Thus water is a free commodity in hills both in term of availability and its transportation. Water harvesting and conveyance in hills are thus carbon neutral.
- The water stored in hills helps in recharge of the ground water at source or downstream and is available in form of springs or ground water table.
- With water availability, the hills can provide opportunity for off season production of agricultural commodities leading to their all season availability in country.
- Mountains provide between 60 to 80 percent of the earth's fresh water. This water is less contaminated and hence requires minimum treatment for drinking purposes.
- On an average, India receives annually 1160 mm rainfall. According to various studies average runoff in mountainous region varies from 10 to 30%. It is estimated that India's 93 m ha mountainous area has the potential of 10.79 million ha m to 32.36 m ha m water yield calculated on the basis of landuse and possible runoff coefficient. This water can be efficiently harvested in catchments through small farm ponds for agricultural and other purposes leading to better crop production and reduction in torrential flow downstream during rains.

STRATEGIES

It is estimated that by 2050, about 22% of the total geographic area and 17% of the population will face water scarcity. Per capita water availability, which was about 1704 m^3 in 2010, is projected to be 1235 m^3 in 2050 (GOI, 2011). This would classify the country as a water stressed region with less than 1700 m^3 water available per person (Falkenmark, 1994). To avoid this situation the following strategies are suggested:

- To improve productivity of sloping lands, first priority is to improve natural resource management practices and technologies particularly for water and soil fertility.
- In India, only 29 per cent of rainwater is being put to productive use. This percentage is much less in hills due to quick runoff through slopes and lack of harvesting structures. Even if 5 per cent of annual rainfall of India is harvested it will be 900 million liters. Therefore rainwater harvesting becomes very important (Gautam, 2016).
- It is estimated that about 24 million ha meter of rainwater can be potentially harvested through small water harvesting structures in India. If about 30 per cent of it can be utilized for supplemental irrigation in about 95 million ha of the country an additional yield of 1 tonnes per hectare can be obtained from this stored water. Remaining 70 per cent of the harvested water would help in recharging the groundwater aquifers thus raising the groundwater level by two meter (Gautam, 2016). In sloping lands, water harvesting and its distribution is much easier as external energy for lifting and conveyance is not required and it will also contribute to recharging of ground water at lower plains.
- Water harvesting is an important tool to make our agriculture more resilient to dependence on monsoon rains. Harvested water can also increase the cropping intensity as in most of the sloping region single cropping is prevalent due to scarcity of water.
- Integrated approach of diversified farm output of fodder, fuel, food, timber, water harvesting and its recycling in sloping lands can bring about a positive response toward natural resource conservation and livelihood security in sloping regions.

- Sloping lands are less favoured areas and have poor infrastructure and market access, therefore, it is uneconomic for farmers to use high levels of external inputs. Thus, locally available low-external-input technologies are appropriate for these lands.

- Major concerns in watershed management programme are (i) maintenance of the assets (water harvesting and conveyance system) after the project period is over (ii) the area to be governed is very big (>500 ha) covering several villages and many a time overlapping panchayat (iii) it requires people participation for effective implementation and sharing of resources and (iv) had a long channel of fund flow.

- To overcome the bottlenecks acquainted in implementation of watershed management programme, the focus should be on individual farmer/ small group of farmers. The sloping lands of the individual farmers can be converted into a prototype of watershed with trees (fruit, timber and fodder) in form of agroforestry in top $1/3^{rd}$ area, hedge row inter cropping (with hedges of fodder yielding trees/shrubs on shoulder bunds associated with agricultural crops) in middle $1/3^{rd}$ area and water harvesting (farm pond) with agricultural crops at the bottom $1/3^{rd}$ area of the farmers sloping lands. The water stored in the farm pond can be recycled as supplemental irrigation and can also be used for fish rearing. This arrangement in sloping lands will be able to achieve the objective of (i) diversified production : leading to economic upliftment and livelihood security (ii) conserving runoff and soil loss : leading to natural resource conservation (iii) availability of water for supplemental irrigation : leading to climate resilience (iv) more biomass production: leading to carbon sequestration and carbon credits (v) Risk reduction : by providing more than 3- 4 outputs from same land unit. This arrangement will also do away with the major concerns of watershed management programs, as mentioned above.

At ICAR-Indian Institute of Soil and Water Conservation, Research Center-Chandigarh, a sloping land was taken up for natural resource conservation and livelihood security. The upper $1/3^{rd}$ portion of the land was put under silvihortipasture agroforestry system involving *Melia composita* (*dek*), *Embilica officinalis* (*aonla*) and *Eulaliopsis binata* (*bhabbhar* grass). The middle portion was converted to terraces and on the terrace risers *Leucaena leucocephala* (*subabool*) was planted at a spacing of two feet in a line which was maintained as hedge of one meter height. Pruned material was used as fodder. After every five meters *Psidium guavajava* (guava) was planted and it was also maintained as hedge. At the lower end of the sloping land a farm pond of 0.12 ha m capacity was dug to collect the runoff water from the above fields. The adjoining land was used for cultivating crops (Figure 1). After six years of implementation of the project it was found that soil loss decreased from 1.22 tha^{-1} in 2010 to 0.17 tha^{-1} in 2015. The system was capable of producing fodder (from *subabool* and *dek*), fuel wood (from *dek* and *subabool*), timber (from *dek*), fruit (from aonla and guava), crops (*rabi* and *kharif*) and fish (reared from July to December in farm pond). The Benefit Cost ratio of the system is 1.41 : 1 and IRR of 16 %. The payback period of the system is 7.2 years. The system provides round the year production and hence fulfills the requirement of the farmers in all the four quarters of the year by providing a range of products (Figure 2). Since tree components are also involved therefore system is eligible for carbon credits.

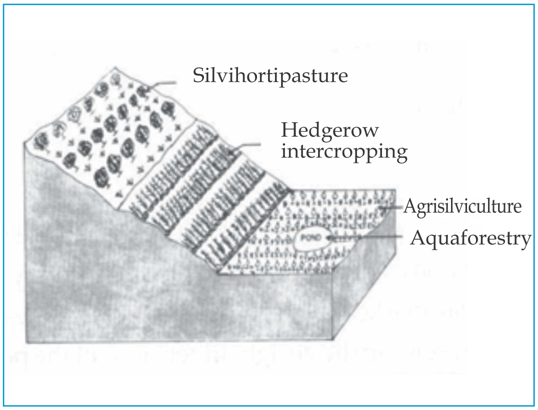

Figure 1. Layout of the system

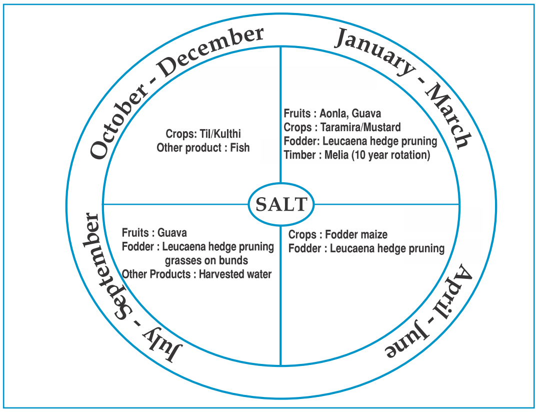

Figure 2. Round the year production from the system

POLICY SUGGESTIONS

- Improved sloping land technology can provide better choices and quality options for sustaining livelihood of upland farmers through diversification of farm and natural resource conservation.
- At present, under PMKSY funding for the components of sloping land technology like water harvesting/farm pond construction is available under watershed

component, water diversion/lift irrigation/water conveyance/precision water application devices like sprinklers *etc* under per drop more crop and construction of terraces/ land levelling under watershed component. Funds for digging of pits for plantations can be met out from MGNREGA. However, in sloping lands farmers are small and marginal and drawing funds for diverse components of the system will be difficult considering different approvals and sanctions. Therefore, a component under PMKSY can be kept as a package for "utilizing sloping lands" with a provision of share of funds of 90:10 (government: individual).

- Project should have phase-wise funding to individual farmer (decentralization for fund utilization) for establishment of sloping system model as it will lead to more accountability of the farmer concerned. Such mechanism is now possible due to efficient working of AADHAR as in case of MGNREGA and other funding schemes and ease of opening of bank account for disbursement.

- Capacity building of farmers particularly in designing of the system (choice of component and placement of component in field) must be made mandatory before funding the system package to the individual farmer.

REFERENCES

Arya, S.L. and Samra, J.S. (2001). Revisiting watershed management institutions in Haryana Shivaliks, India. Central Soil and Water Conservation Research and Training Institute, Research Centre- Chandigarh : 329p.

CGIAR (1997). Report of the study on CGIAR research priorities for marginal lands. TAC Secretariat, Food and Agriculture Organization of the United Nations March 1997: 9pp.

Dhandapani, K.R. and B. Rath (2004). Country Report - India in Sustainable Farming Systems in Upland Areas. Edited by Dr. Tej Partap, Published by Asian Productivity Organization 1-2-10 Hirakawacho, Chiyoda-ku, Tokyo 102-0093, Japan: 99-106.

Falkenmark, M. (1994).Landscape as life support pro-vider water-related limitations. In: Graham-Smith F, ed. Population: The Complex Reality. London (UK): The Royal Society, pp 103-116.

FAO (2015). Mapping the vulnerability of mountain peoples to food insecurity. Romeo, R., Vita, A., Testolin, R. & Hofer, T. Rome. www.mountainpartnership.org

Gautam, H. R. (2016).Water Availability Crisis and Ways to Check the Depletion. Yojna, July, 2016 (web exclusives).

GOI (Government of India) (2011). State of Indian Agriculture 2011-12. Ministry of Agriculture, GoI, New Delhi, India. 294p.

Ministry of Agriculture (MOA) (1996). National Workshop on Himalayan Farming Systems, Government of India, New Delhi.

NAAS (2011). Drought Preparedness and Mitigation. Policy Paper No. 50, National Academy of Agricultural Sciences, New Delhi. pp 22.

Pratap, Tej (1998). Marginal Lands and Marginalized Farmers of the HK-Himalayan Region: Sustainability Challenges and Opportunities, paper presented in DSE-ZEL-ICIMOD International Conference on Mountains 2000 and Beyond: Sustainable Development of the HK-Himalayan Region, 21-23 June1998, Wildbad Kreuth, Feldafing.

Singh, G., Ram Babu, Narain, P., Bhushan, L.S. and Abrol, I.P. (1992). Soil erosion rates in India. J. Soil & Water Conservation, 47(1) : 97-99.

Tiffin, M., Mortimore, M. and Gichuki, F. (1994). More People and Less Erosion: Environmental Recovery in Kenya, John Wiley and Sons, New York.

Yadav, R.P. and Sidhu, G.S. (2010). Assessment of Soil Erosion in Himachal Pradesh. Journal of the Indian Society of Soil Science, 58 : 212-220.

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