Indian Farming **67**(12): 23–25; December 2017

Restoration of degraded *Jhum* lands through hedge-row

Rakesh Kumar[1], Pravin Kumar Upadhyay[2], Ravikant Kumar[3] and Rajiv Kumar Singh[4]

ICAR Research Centre for Eastern Region, Patna (Bihar) 800 014

Hedge-row species seems to be beneficial even for soil fertility enrichment in jhum *fallows. After forest clearing and subsequent burning of slash, ecosystem loses its ability to hold nutrients. Studies on soil-fertility depletion and recovery patterns under shifting cultivation suggest that fertility is generally lower under short-cycle (5 years) than under a longer one, and recovery process is generally significant only after 10 years of fallow, until then there is a rapid uptake of elements by the vegetation before substantial release through litters occurs. Significant improvement of soil fertility was observed through addition of pruning of hedge-row crops.*

Key words: Degraded lands, Hedge row, *Jhum* lands, Restoration



View of *jhum* land at Wokha, Nagaland



Maize in hedge row cultivation

SHIFTING cultivation/slash and burn agriculture locally known as *jhum* is the main stay of agriculture in the north-eastern hills region practising with the traditional knowledge. It drastically declines the soil fertility and land became unsustainable primarily due to increase in the population pressure that led to increase in the food demand in the region. Therefore, the growing of hedge-row crops act as restoration factory to maintain soil fertility for sustainable crop production. Hedge-row species protect the bare soil against erosion, which helps in restoration of the soil fertility through improvement in physical, chemical and biological properties of the soil. The problem is more severe in *jhum* lands, where organic matter, nutrients and microbial biota lost due to the burning of forests. These can be mitigated to a great extent through growing of hedge row, which will improve organic matter, macro-and micro-nutrients status of the soil and conserving the moisture *in situ*. Hence, hedge-row species might be ways for improving soil-health improvement as well as crop productivity for the poor tribal farming community of this region. Generally, the green-manuring crop is incorporated into soil, when they develop enough biomass as tender and succulent leaves and twigs are at green stages or just before the flowering stages in rainfed areas for improving soil-health and conserving moisture *in situ* because organic matter in the soil is recognized as one of most valuable indicator and constituents for realizing the fertility status. It was noticed that role of N-fixing plants in the cropping systems diminished in 1940s, when relatively inexpensive and abundant fertilizer became available. The growing of leguminous crop to be worked into the soil is an old aged agricultural practice that is increasing popularity now-a-days. However,

Table 1. Total biomass production (q/ha on dry wt. basis) of different hedgerow species

Hedge species	Root	Stem	Leaves	Twig	Total biomass
Cajanus cajan	40.10±8.81	65.40±3.65	17.27±4.08	45.78±11.5	168.55±17.15
Crassula tetragona	46.36±12.9	186.7±35.0	49.41±9.41	48.63±10.3	331.13±60.02
Desmodium rensonii	32.81±5.36	44.55±8.40	11.77±2.23	6.15±0.20	95.28±15.55
Flemengia macrophylla	45.70±9.45	41.34±3.15	20.47±1.05	2.97±0.35	110.48±17.13
Indigofera tinctoria	25.73±6.99	94.73±14.3	17.25±6.36	4.55±0.83	142.26±34.98
Tephrossia candida	18.94±2.17	54.50±8.71	27.25±4.30	6.75±0.72	107.44±17.54

Laxminarayana *et al.* (2005)

availability of N is highly associated with the organic matter contents and its decaying is influenced the availability of nutrients in the soil. For these reasons, it has seemed to discuss amount of organic matter in the soil, its source and influences. Organic carbon improves physical, chemical and biological properties of the soil. In hilly terrains, perennial water sources are available, where these hedge row species can be grown successfully for improving the soils-health for degraded *jhum* land, where the organic matter, NPK and other micro-nutrient contents are noted highly deficit. It is a viable alternative option to maintain the *jhum* land productivity, and sustainability in a longer perspective.

North-eastern hills region has infinite varieties of geographical setting. Out of 26.2 m ha geographical area, 10.8% has an elevation between 300 and 600 m, 17.9% between 600 and 1200 m and 28.3% >1200 m. Average annual rainfall varies from 2,000 to 4,000 mm and received from south-west monsoon . The yield of agricultural crops in this region is more unstable in rainfed areas than irrigated ones due to the unpredictable climate changes. An estimate showed that ~3.5 m ha land under rainfed cultivation accounting ~30% of the total area. Renovation crops and pastures are those which are returned to soil with the aims of improving fertility status of the soil. The similar concept was tested under the lowland condition for *in situ* biomass generation for soil fertility management and to reduce dependence on external inputs. Hedge-row species like *Tephrossia candida, Crotalaria juncea, Indigofera tinctoria, Flemengia macrophylla* and *Cajanus cajan* were grown on the alternate raised bunds in paddy field. A good amount of biomass has been produced to supplement the nutrient-requirement for these crops. Hedge-row cropping is a type of intercropping, where arable crops are grown in between alleys (inter-space) formed by the two hedge-rows depending upon slope and species. However, alley width may vary from 2 to 5 m and hedge-rows shrubs i.e. *Crotolaria, Tephrossia, Casia, Acacia, Cajanus cajan, Flemingia, Indigofera* sp. are the most suitable as alley crops for ginger, turmeric and maize. However, height of alley crops is maintained at ~1 m by pruning them periodically, biomass is either used as mulch/ incorporated into the soil as a source of the nutrient. Their vigorous root system mobilizes P and K. Decomposition of organic matter liberates CO_2 and organic acids and solublizes P, K, Ca and other trace elements. Accumulation of organic matter through litter fall of hedge row crops improves the water holding capacity of the soil and other physical properties. The following properties of hedge-row species are suitable for improvement in degraded *jhum* areas of north-eastern hills region:

- High rate of production of leaf biomass.
- Dense network of root system.
- High rate of nitrogen-fixation ability.
- Sturdy in nature and thrive well in adverse situation.
- Tolerant to moisture stress and diseases and pest incidences.
- High and balanced nutrient content in the foliage.
- Litter of high quality having high nitrogen, low in lignin and polyphenols.
- Rapid litter decay, when nutrient release is desired.
- Absence of toxic substances in the litter or root residues.
- Capable to grow on soils having low fertility.

Intercropping with hedge-row crops is a well proven and sustainable technology for this region. Hedge grown on contours help in developing the natural terrace in few years of time interval. However, growing of different hedge row species reduces erosion and conserving moisture and nutrients in the soil *in situ*. Further, studies revealed that the on an average, through pruning of hedge-row crops, an amount of 20 to 80, 3 to 4 and 8 to 38 kg NPK/ ha /year, respectively were added into the soil. Among species, highest biomass was recorded in *C. tetragona* (331.1 q/ ha). Total above ground biomass was recorded >80% in *C. tetragona, I. tinctoria T. candida,* and *C. cajan* partitioned >70% above ground biomass. Among various plant parts, root biomass was highest (41.4%) in *F. macrophylla*, whereas *C. tetragona, T. candida,* and *C. cajan*, respectively showed highest biomass for shoot (56.4%), leaves (25.4%) and twigs (27.2%), Table 1.

Nutrient concentration of foliage in different hedgerow species

Total N, P and K concentration in the foliage ranged from 3.23 to 3.86; 0.32 to 0.81 and 1.26 to 1.67% receptively (Table 2). Among various hedge-row species, *I. tinctoria* continued highest N in foliage (3.86%), followed by *D. rensonii* (3.63%) and *T. candida* (3.57%). The higher concentration of N in foliage of all hedge-row species might be due to fixation of atmospheric N_2, mineralization of organic matter and subsequent accumulation in foliage. Highest P content (0.81%) was observed in the foliage of *I. tinctoria* followed by *C. cajan* (0.67%). Foliage of *T. candida* although

Table 2. Nutrient content in leaf biomass of different hedge species

Hedge crops	Nutrient concentration (%)		
	N	P	K
Cajanus cajan	3.29±0.14	0.67±0.034	1.43±0.033
Crassula tetragona	3.47±0.13	0.48±0.042	1.63±0.034
Desmodium rensonii	3.63±0.27	0.48±0.025	1.56±0.025
Flemengia macrophylla	3.23±0.04	0.45±0.025	1.26±0.025
Indigofera tinctoria	3.86±0.13	0.81±0.042	1.63±0.041
Tephrossia candida	3.57±0.09	0.32±0.034	1.67±0.042

Laxminarayana *et al.* (2005).

Table 3. Nutrient accumulation through leaf biomass of different hedge species

Hedge-row species	Leaf litter (q ha^{-1})	Nutrient accumulation (kg ha^{-1})		
		N	P	K
Cajanus cajan	7.82	25.73	5.24	11.18
Crassula tetragona	22.98	79.74	11.03	37.46
Desmodium rensonii	5.31	19.28	2.55	8.28
Flemengia macrophylla	6.46	20.87	2.91	8.14
Indigofera tinctoria	16.99	65.58	13.76	27.69
Tephrossia candida	15.30	54.62	4.90	25.55

Laxminarayana *et al.* (2005).

contained lowest P content (0.32%) but potassium was highest (1.67%) in its foliage. Of all the N_2-fixing hedgerow species, *I. tinctoria* is more promising for plantation on the contour bunds considering its potentiality in nutrient concentration of the foliage.

Soil-fertility buildup

Total leaf biomass production on dry weight basis after one year of growth was found to be highest in *C. tetragona* (22.9 q/ha) followed by *I. tinctoria* (16.9 q/ ha) and *T. candiada* (15.3 q/ ha). Among hedge-row species. *C. tetragona* enriched the soil fertility more efficiently through its leafy matter as it accumulated higher amount of Total N, P and K being the mean values of 79.7, 11 and 37.5 kg/ha, receptively (Table 3).

Scientists reported that annual pruned biomass of hedge-row intercropping may be ~2 tonne/ha in semi-arid zone and 16 to 20 tonne/ha or more for *L. leucocephala* in a fertile humid regions. Nutrient content of leafy pruning from fast growing N_2-fixing trees was reported in range of N-2.5-4%, P-0.1-0.5%, K-1.0-2.5% and Ca-1.5-2%. Pruning has advantages over natural litter in that leafy matter is transferred before loss of nutrients by senescence. These nutrient contents in leafy matter resulted of 120 to 200 kg N, 5 to 15 kg P, 50 to 100 kg K and 70 to 100 kg Ca / ha into soil.

SUMMARY

During one cropping phase, agricultural systems in north-eastern region hills, soil may lose the 600 kg N/ha and half of this amount is recovered during subsequent 5 years of fallow period in *jhum* areas. However, an accelerated and directed succession trough introduction of variety of legumes and non-leguminous nitrogen-fixers during cropping and fallow phase could restore soil fertility over a short (5-year) cycle period. Contour hedge-row technology provides an option for farming on hills slopes on a sustainable basis. Growing of nitrogen-fixing hedge, crops on field bunds helps in fixation of atmospheric N and reduces leaching losses of nitrogen. Addition of leaf biomass through hedge row cropping resulted in significant improvement in fertility status of soil and lowered soil acidity remarkably from its initial levels.

[1]Scientist (Agronomy), Division of Crop Research, ICAR RC for Eastern Region Patna-800 014; [2] Scientist, Division of Agronomy, IARI New Delhi-110 012; [3] SRF, CRP on CA Project, Division of Crop Research, ICAR RC for Eastern Region Patna, Bihar 800 014 ; and [4]Senior Scientist, Division of Agronomy, IARI, New Delhi-110 012. Corresponding author e mail : pravin.ndu@ gmail.com

ICAR New Portals

The Council has created the following portals for effective governance by utilizing the information and communication technology.

ICAR Data Centre and Unified Communication portals to secure institute information and information transmission.

- ICAR-Enterprise resource planning (ERP) System to this manage the human resource in information of the council including pay roll, finance and budgeting.
- KVK Knowledge Network Portal (http://kvk.icar.gov.in) to share basic information and facilities of KVKs with contingency plans, demonstration schedule, and advisories.
- Management System for Post-Graduate Education (MSPGE) enabling academic and e-learning modules while also being a repository of academic records
- E-*Samvad,* an online interface of the Council to answer citizens queries.
- KRISHI –A knowledge repository portal of digital information pertaining to research experiments, outputs, publications, etc.
- E-*Krishi Manch*, a dedicated portal for farmer-scientist interaction.