ICAR stresses on climate resilient cropping system {Maize- black gram (*Pahenlo dal*) – buckwheat} to enhance the cropping intensity in Sikkim

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Agriculture in Sikkim was traditionally low-input driven until officially the state was declared organic in 2003 and attained fully organic status in 2016. The decision of Govt. of Sikkim to go organic was based on the premise that farming in this hilly state was low synthetic input based and conversion would benefit the sixty two thousand farming families of the state holding an average 1.9 ha of farmland and also to maintain the quality of environment. A live healthy soil with proper cropping patterns, crop residue management and effective crop rotation can sustain optimum productivity over the years without any loss of soil fertility. Organics not only help in nutrient cycling and increasing agricultural productivity but also stabilize soils against erosion and floods, detoxify ecosystems and may even help counteract climatic change by restoring soil's capacity to sequester carbon.

In Sikkim, maize occupies maximum acrage (40,000 ha) and is sown in the *pre-kharif* season starting from February to mid-March. However, its productivity is 47 per cent lower (1680 kg/ha) than the national average (2476 kg/ha). Generally, the productivity of all the food crops in Sikkim is lower than the national averages. Among the various reasons for low productivity, one finds the role of proper nutrition and water management in plant growth of paramount importance. Nutrient self-sufficiency is a desirable characteristic of agronomically sustainable cropping systems. In order to create self-sufficiency in organic food production to feed the population of the state and the floating population with quality food, sound organic package of practices for rainfed systems is required which includes nutrients, weed and crop protection management aspects which assumes even greater significance under the climate variability.

The rainfall pattern in Sikkim has become quite erratic in the last few years when compared with Long Period Average (LPA) for the period 1957 to 2005 with the present pattern of rain fall and temperature. Sikkim received on an average 26 per cent less rain fall in the month of May and 8 per cent less rain in June and 10 per cent less rain in the month of July for the year 2006 to 2009 as compared to LPA of 1957 to 2005. Unseasonal rainfall, rising temperatures, dry winters (esp. during the last decade) are already being experienced in the state. The basic water supply system consists of tapping of water (sources) located at higher reaches where

springs flow from the water reserved in the sub-surface aquifers of rocks. But these aquifers in the rock stratus have to be charged with rain water which happens only, if there is enough rainfall and vegetation to hold the moisture. Besides, Sikkim has 89 per cent area under rainfed agriculture. Hence, majority of the farmers are naturally forced to follow maize-fallow rotation production in sukhe-bari. Sikkim enjoys very scanty rainfall during winter seasons (89% area under rainfed). Therefore, the resource poor farmers are not able to sustain their livelihoods. Hence, the cropping intensity of the state is merely 117 per cent for the last many years. Keeping these in view, the ICAR Sikkim contemplated an alternative and developed a "C**limate resilient maize - black gram (*Pahenlo dal*) – buckwheat system for rainfed mountain ecosystem under organic management**". After two years of experimentation and their benefits thus obtained at ICAR Research Farm decided to expand it through frontline demonstrations at farmers field.

Technology intervention by ICAR - NOFRI

In Sikkim, farmers generally grew local cv. of maize due to its taste and aroma, which takes around 140-155 days from seed to seed. While composites varieties (Vivek Sankul -31, Vivek Sankul-35, RCM 1-1, RCM 1-3, RCM-75 and RCM-76) tested at ICAR Sikkim matures around 110-115 days from seed to seed. It saves around 30-40 days over traditional varieties grown by farmers in Sikkim. This duration is utilized for second and third crop in rotation (black gram and buckwheat). Similarly, during the winter season farmers in Sikkim are unable to grow any crop due available soil moisture stress as no and/ or very scanty rainfall is received during the period (October to February). Hence, for growing *rabi* season crops especially for buckwheat at least 30 per cent maize stover and weed biomass is used as mulch for reducing the evaporation from soil surface and maintaining the soil temperature. Detailed activities are given in Table 1.

Table 1: Package of practices for Maize (green cobs)- black gram (*Pahenlo dal*)-buckwheat: A climate resilient cropping system.

S. no.	Package of practices	Maize	Black gram (*Pahenlo dal*)	Buckwheat
1.	**Land preparation**	One ploughing with bullock drawn plough followed by one tilling/harrowing to be done for maize after harvest of buckwheat.	After harvesting of maize undertake surface cleaning by hand weeding and only open the furrow for placing the seed under no-till condition.	After harvesting of black gram, clean the surface by hand weeding and only open furrow for placing the seed under no-till condition.

2.	**Organic nutrient management**	Apply dolomite @ 2 t/ha as basal application 15-20 days prior to the sowing followed by conjoint basal application of mixed compost @ 2.5 t/ha and neem cake @ 0.5 t/ha followed by application of vermicompost @ 2.5 t/ha in two equal splits *i.e*., half amount applied in rows at the time of sowing and the rest amount at the time of earthing up after second weeding.	FYM or mixed compost @ 5 t/ha should be applied as basal application 10-15 days prior to sowing followed by goat manure/poultry manure @ 1-2 t/ha as basal dose to overcome micronutrient deficiencies.	Vermicompost should be applied @ 1.5 t/ha in two equal splits *i.e*., ½ at the time of sowing and half 45 days after sowing in furrows.
3.	**Time of sowing**	Second fortnight of March to first week of April.	Second fortnight of July to first fortnight of August.	First fortnight of November.
4.	**Varieties**	Vivek Sankul-31, Vivek Sankul -35 Lines: RCM 1-1, RCM 1-76, RCM 1-3.	SKPD-3, local *cv Pahenlo dal.*	Local *cv Mithe.*
5.	**Method of sowing:** **a) Seed rate and seed inoculation**	20-25 kg/ha seed should be inoculated with *Azospirillum*, *Azotobacter etc*. and Phosphorus solubilizing bacteria (PSB) @ 20 g/kg seed before sowing.	20-25 kg/ha seed should be treated with *Rhizobium* and PSB @ 20 g/kg seed.	35-40 kg/ha seed should be treated with Azophos @ 20 g/kg.
	b) Spacing and depth of sowing	Spacing of 50 cm x 25 cm on the ridge/flat bed. Sown at a depth of 3 to 5 cm.	Sown on ridge with spacing of 30-40 cm x 10 cm.	Spacing of 30 cm to 45 cm row to row spacing and 10 cm to 15 cm from plant to plant with sowing depth of 3 to 5 cm.
b)	**Weed management**	Two hand weeding, first at 15-20 DAS and second at 35-40 DAS.	One hand weeding 15-20 DAS and second weeding at 40-45 DAS, if required.	Generally, no weeding is required. However, one hand weeding at 20-25 DAS in case of higher weed infestation is recommended.
c)	**Crop protection: Insect pest management.**	Spraying of neem formulations 1500 ppm @ 3 ml/l or Spinosad 45 SC @ 0.3 ml/l and second spray at 20 days interval is effective to control insect pests of	Mechanical collection and destruction of Blister beetle, Bihar hairy caterpillar and *Helicoverpa*	

		maize.	*armigera* is highly effective for management. Spraying of entomopathogenic fungi like *Beauveria bassiana* and *Metarhizium anisopliae* @ 5 g/l.	
	Disease Management	**Turcicum leaf blight**(*Helminthosporium turcicum*): ❖ Grow resistant hybrids like DHM-1. ❖ Remove plant residue from the previous crop. ❖ Plough under the infected crop residue in the field to reduce the inoculum. **Maydis leaf blight** (MLB) (*Bipolaris maydis*): ❖ Grow resistant varieties like Deccan, VL-42, Prabhat, KH-5901, PRO-324, PRO-339, ICI-701, F-7013, F-7012, PEMH-1, PEMH-2, PEMH-3, Paras, Sartaj, and Deccan 109. ❖ Remove infected crop debris. **Downy mildews:** ❖ Use resistant varieties like DMR-1, DMR-5 and Ganga-11. ❖ Remove infected crop debris. ❖ Provide proper drainage to avoid water stagnation in the field.	**Yellow mosaic virus:** ❖ Remove and destroy the infected plants. ❖ Apply neem oil @ 0.3 per cent or NSKE @ 5 per cent to control white fly. ❖ Use increased seed rate (25 kg/ha). **Urd bean leaf crinkle** (Urd bean leaf crinkle virus): ❖ Remove and destroy the infected plants. ❖ Use disease-free seeds. ❖ Use increased seed rate (25 kg/ha). ❖ Hot water treatment of the seed at 55^{o} C for 30 minutes. ❖ Remove weed hosts periodically. **Rust** (*Uromyces phaseoli*) ❖ Adjust the sowing date to escape from the disease. ❖ Apply wettable sulphur @ 0.25 per cent.	**Downy mildew** (*Peronospora ducometi*): ❖ Select seeds from disease-free plants. ❖ Treat the seeds using *Trichoderma viride* @ 4 g/ kg of seeds. ❖ Soil application of *Trichoderma viride* @ 2.5 kg mixed with 50 kg sand or well rotted FYM. ❖ **Powdery mildew** (*Erysiphae polygoni*) ❖ Select seeds from disease-free plants ❖ Apply wettable sulphur @ 0.25 per cent.

			Powdery mildew (*Erysiphe polygoni*): ❖ Dust sulphur two to three times during the cropping season. ❖ Apply wettable sulphur @ 0.25 per cent. ❖ Spray eucalyptus leaf extract @ 10 per cent at the onset of disease and 10 days later. ❖ Spray NSKE @ 5 per cent or neem oil @ 3 per cent twice at 10 day interval from initial appearance of the disease.	
d)	**Harvesting**	Plucking of green cobs should be done in two-three stages for obtaining proper size of cobs. After cob plucking, stalk should be cut 25-30 cm above the ground removed from field and used as green fodder.	Pod picking should be done when most of the pods turn black, over maturity causes shattering of pods. Picking should be done preferably during morning or evening hours to prevent shattering losses while handling the pods.	Timely harvesting of buckwheat is essential to prevent shattering of grains. Due to its gradual formation and maturity, harvesting is done periodically and finally the crop is cut and then threshed when the rest of the seeds are fully matured.

Technology expansion

In order to increase the cropping intensity from existing 119 to 300 per cent in the state, ICAR-National Organic Farming Research Institute, Tadong, Gangtok organized various training cum input support programme during 2015-16 in different villages of Sikkim. During

last year (2015-16), the technology was demonstrated in the fields of 110 farmers covering of an area of 10.4 ha in different locations and recorded higher B:C ratio of 2.59 over farmers' practice 1.14 (maize-fallow). This year also we are expanding the area involving around 200 farmers where these technology are being demonstrated. In most of the areas, maize has been harvested and sowing of *pahenlo dal* is under process. Keeping the importance of the technology all the four Krishi Vigyan Kendra of Sikkim are also suggested to take up the technology in the larger interest of the farming community for enhancing the livelihood and ensuring 300 per cent cropping intensity which will help in conserving and enhancing precious soil resources.

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Maize - Pahenlo dal (Black gram) – Buckwheat