A success story
on
Zero tillage pea cultivation creates impact under climate stress condition

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Prologue

The Nongthymmai village in Ri-Bhoi district of Meghalaya under the subtropical hill agro-climatic zone is a climatic vulnerable village mostly affected by acute scarcity of water during rabi season. The main occupation of the village population rests on agriculture and allied activities with around $1/4^{th}$ of cultivable area under *jhum* farming. The farmers of Nongthymmai village use to grow different type of crops like rice, maize, soybean, tomato, brinjal, ginger and turmeric etc. but with a low cropping intensity of hardly about 110-120%. Generally, most of the farmers in the village prctice mono-cropping system of rice cultivation. Instead of taking up any second crop after Kharif rice, the farmers of this village keep their rice field fallow during rabi season owing to release of excess moisture through seepage from surrounding hillocks immediately after rice followed by long dry spell of rainfall during November- March, lack of irrigation facilities, high run-off water loss etc. Cultivation of boro rice becomes impossible due to onset of severe winter which results in spikelet sterility thus putting the socio-economic status of farmers of the village, at a dismal state. Therefore, in order to enhance the cropping intensity of the village by using the local available resources like residual soil moisture and existing crop residues of kharif rice; ICAR Research Complex for NEH Region, Meghalaya introduced the no-till technology the best possible resource conservation technology (RCTs) in Nongthymmai village under National Innovation on Climate Resilient Agriculture (NICRA) Technology Demonstration (TD) component.

What is no-till cultivation or no-till or Zero tillage?

No-till, also referred to as zero tillage, is a soil cultivation system in which seeds are deposited or placed directly into untilled soil. It is defined as a system of planting crops into untilled soil by opening a narrow furrow only of sufficient width and depth to obtain proper seed soil contact. No other soil tillage is done.

No-till (NT) needs only negligible soil disturbance and the residues from previous crops remain largely undisturbed at the soil surface as mulch while conventional tillage (CT) completely inverts the soil creating more disturbances to the soil physical properties and depletion of nutrients. Soil erosion control and soil and water conservation is seen as the clearest benefit of no-till.

No-till farming is not concerned only with soil tillage. It encompasses four broad management practices:

1. Minimal soil disturbance (no ploughing and harrowing)
2. Maintenance of a permanent vegetative soil cover (residue retention)
3. Direct sowing and
4. Sound crop rotation (preferably with fertility building crops such as legume)

Climate change mitigation through No-till

1. Improves soil carbon sequestration

2. Reduces GHG emissions from soils
3. Reduces fossil fuel use
4. Reduces synthetic nitrogen fertilizer use (increase nutrient use efficiency)

No-till has a great potential for adapting smallholder farming systems to changing climatic conditions. No-till conserves the natural resources of soil and water through various mechanisms. The mulch layer minimizes evaporation for a certain period of time, and in regions where low rainfall occurs, this can conserve water and increase the water-use efficiency of the cultivated crops. Furthermore, the change in infiltration and runoff rates can have major effects on the total water balance, which is important in sustainable production systems. The permanent soil cover and minimum disturbance resulting from no-till also increase soil organic matter, at least in the top 10 cm of the soil which promotes in improving the aggregate soil health. No-till seems to be an appropriate strategy for adapting agricultural production systems to climate change by preserving water and soil resources that climate-change scenarios identify as being particularly threatened. Accumulation of organic matter in the topsoil of croplands because of permanent soil cover by mulch is a key mechanism for the observed soil and water conservation benefit. Soil carbon sequestration is by far the most important aspect of conservation agriculture and no-till which promote climate resilient agriculture.

Justification of the No-till cultivation technology with relevance to mitigating climate change

1. It enhances conservation of soils by increasing the soil aggregate stability and soil organic matter in top soils through various indirect impacts including reduced soil erosion and increase plant availability of soil water.
2. It enhances conservation of water by reducing run-off, evaporation losses, increase water infiltration and higher soil water retention through reduction of soil erosion, more plant available soil water, increase in recharge of aquifers and reduction of soil erosion even to rates below soil formation rates.
3. No-till has carbon sequestration potential through storage of soil organic matter in the soil of crop fields.
4. No-till cultivation helps in mitigating greenhouse gas through enhanced carbon sequestration in the soil because less the soil is disturbed, the more organic matter can be retained in the form of stored carbon, which therefore does not contribute to global warming in the form of CO emissions
5. Lastly, a technology can only be considered as successful when fully embedded within the local social, economic, cultural context and adapted in wide areas. Thus, the suitability and adoption of a new technology in one place – for example, the use of no-till in a state – does not imply the conditions for its adoption.

Steps followed in no-till cultivation technology.

1. Rice crops are harvested leaving atleast 15-20 cm crop stubbles to conserve the soil moisture. If the rice field have high moisture content, then height of the rice stables should be reduced by about 5-10 cm in order to allow more soils moister evaporation these making it suitable for the no-till cultivation.
2. The existing weeds or previous crops are controlled by spraying of herbicides atrazine, simazine, glyphosate, alachlor, fluchloralin, butachlor etc.
3. Furrows should be opened with furrow opener for placing the seeds between the stubbles.

4. Manure and fertilizer are applied so that the soil physical properties and nutrients can be stored for utilization by crops.

Advantages of No-till cultivation technology with respect to North East Region

- ❖ After rice harvest, due to excess soil moisture ploughing for raising an arable crop is not possible. No-till overcomes such constraints in crop products.
- ❖ The optimum time for sowing of pea/lentil (Oct/Nov) and rapeseeds (Sept/Nov) are important for good harvest. Rice is harvested by the end of October, leaving very limited time for sowing rabi crops. Under such conditions No-till facilitates early sowing of crops without wasting time.
- ❖ Saves about Rs. 2500/ha due to avoidance of tillage.
- ❖ Avoidance of tillage saves about 40-50 litres diesel/ha which is equivalent to 132.5 Kg of CO_2 (1 litre of diesel produces 2.65 kg of CO_2). Thus, reduces the emission of Green House Gases.
- ❖ Reduces the cost of cultivation and thus, enhances the income
- ❖ Promotes crop diversification and enhances cropping intensity.

The Nongthymmai village normally receives a rainfall period around eight months from March to October with maximum average rainfall of 400 mm spreading over four months i.e. from of mid May to mid August and the remaining four months receives no rain (Fig. 1).But due to climate change there was shifting of rainfall period leading to acute scarcity of water and moisture stress during November to February and rise in temperature of the region with a maximum temperature of 32^0C and minimum temperature of 12^0C as compared to preceding years for which the farmers of the village keep their land fallow after harvesting of Kharif rice by the end of November. The only solution to this problem is No-till cultivation in rice-fallow, which is an appropriate resources conservation technology (RCT) for enhancing the cropping intensity, boosting farm income and improving livelihood status of farmers. It is an energy saving technology, helps in building up of soil health due to no- tillage and enhances soil microbial activities.

Fig 1. Frequency of rainfall in Nongthymmai

In order to have a successful intervention of *No-till technology* in Nongthymmai village as a climatic resilient technology; initially some capacity building programmes were organized on *No-till technology* in which skill based knowledge on the technology was imparted tothe farmers for augmenting the production and productivity of second crop after rice under low soil-moisture regime by reduction in tillage, retention of adequate


Fig 2. Field day on No-till Pea organized for technology

amount of crop residues for moisture conservation and soil organic matter maintenance thereby enhancing the cropping intensity that lead to increase in income and ameliorate the socio-economic status of the farming community of Nongthymmai village. Appropriate training programme and field demonstrations were conducted in farmers field and in ICAR field, Umiam for dissemination of the technology (Fig 2).

Training –cum- field demonstration on No-till cultivation of peas by ICAR Scientist in Nongthymmai Village


Fig 3.Demonstration of no-till technology in farmers' field

Initially, the no-till cultivation technology was adopted by one progressive farmer Mr. Stephan Shadap in Nongthymmai village during 2011-12. Mr. Stephen Shadap is the President of Nongthymmai Development Society in Umsning block of Ri-Bhoi district of Meghalaya. Thirty five years old Mr. Shadap is a progressive farmer of the village with about 1.0ha of land holding. Apart from involving himself in various developmental activities in the village, he practices improved agricultural production technology of rice, maize, ginger, tomato etc. as per the recommendation of ICAR Research Complex for NEH Region, Meghalaya. Till November, 2011; he was following only mono-cropping system of cultivation. His rice field was lying fallow after the harvesting of kharif rice resulting very low cropping intensity in his farming system. As, the village was facing acute water deficit during rabi season (November- March), no-till technology was recently introduced to ascertain the adaptability of second crops during the moisture stress condition. A demonstration on **"No-till Pea Cultivation"** was taken up in Nongthymmai village under the scientific guidance of ICAR scientist along with training of the farmers.

Fig 4. Making furrows for Zero tillage pea

Fig 5.FYM application in furrows

Fig 6. Pea showing in furrows

Initially, the leader of the Nongthymmai village Development Society, Mr. Stephen Shadap came forward along with four other farmers of Nongthymmai village to take up the no-till method of cultivation on garden pea covering around 1.5 ha. ICAR provided all the critical inputs like seeds, fertilizers, FYM etc. for successful demonstration on No-till cultivation of Peas. Thereafter, regular monitoring of the demonstration programme was made by scientists and NICRA project staff through frequent village visits and timely advisory services.

Effect of the technology:

The demonstration on ***No-till cultivation of Peas*** was conducted in Nongthymmai village continuously for four consecutive years from 2011-12 to 2014-15. Initially during the year 2011-12, the no-till cultivation of peas was demonstrated in Nongthymmai village with the involvement of 5 farmers under the leadership of Mr. Stephan Shadap covering about 1.5 ha. of land. The zero tillage technology has been demonstrated successfully since last four years starting from 2011-12 to 2014-15. In this technology after the harvest of rice, one more crop could be taken up with no tillage so as to maintain the available soil moisture for the second crop. The rice stubbles up to 15-20 cm height were left in the field as such. Using an adjustable furrow opener furrows were made in between two rows of rice and garden peas were sown maintaining a plant to plant distance of 5-10 cm and line to line distance of 45-60 cm followed by application of FYM @ 5 t/ha. When the pea crop was grown to about 15-20 cm height the rice stubbles are then used as mulch. This RCT demonstration was a success story in NICRA-TD adopted Nongthymmai village under the climate change situation.

The result of this demonstration as shown in table 1revealed that during the last four years the area and productivity under the zero tillage pea cultivation has been increased tremendously enhancing the crop intensity to around 135 %. In case of zero tillage pea demonstration the yield of double cropping (Rice + Pea) was estimated to be 64.25 t/ha during 2011-12, 69.65 t/ha during 2012-13, 71.55 t/ha during 2013-14 and 74.00 t/ha during 2014-15, which showed nearly two-fold increase in yield over the mono cropping rice (control) i.e. 36.85 t/ha (2011-12), 37.25 t/ha (2012-13), 38.15 t/ha (2013-14) and 39.23 t/ha (2014-15) respectively, thus enhancing the net income per ha to the tune of three fold in case of rice-pea cropping sequence as compared to rice followed by fallow due to high price of field pea in the market. Under zero tillage pea in rice fallow, the average net income varied from Rs. 47,200 (2011-12) to Rs. 69,400/- (2014-15); where as it was fluctuated form Rs. 17,250/- (2011-12) to Rs. Rs. 18,904/- (2014-15) in case of monocropping rice. In course of time the area and the number of farmer participants under this technology were increased to 10 farmers covering 4.5 ha. of land during 2012-13 and again in the third year (2013-14) it was extended to 25 farmers with area coverage of 7.25 ha and in the fourth year (2014-15) it was further extended up to 30 farmers with area coverage of 9 ha, which, indicated that this technology has been adopted

successfully in Nongthymmai village. The average yield in case of demonstrated rice-pea cropping sequence under no-till cultivation was also very encouraging than that of rice-fallow cropping system (monocropping)implying increase in cropping intensity under no-till. In all the cases the rice-pea cropping sequence under zero technology was found to earn more net income with impressive B:C ratio of 1.96, 2.22 and 2.27, 2.28 as compared to 1.88, 1.94, 1.92 and 1.93 under rice-fallow (monocropping) system during the 2011-12, 2014-15 respectively.

Table 1: Economic return from different cropping sequences rice –fallow (monocropping) *VS* rice-pea (no-till)

Year	No. of farmers involved	Area covered (ha)	Cropping sequence		Av.yield (q/ha)	Gross Expenditure (Rs./ha)	Gross Income (Rs./ha)	Net Income (Rs./ha)	B:C ratio
2011-12	-	-	**Rice-fallow** (var. Shahsarang) *(Monocropping)*		**36.85**	**19,600**	**36,850**	**17,250**	**1.88**
	5	**1.5 ha**	**Rice- Pea** *(Zero tillage)*	**Rice** (var.Shahsarang)	35.00	18,500	35,000	16,500	1.89
				Pea (var. Vikash)	29.25	30,500	61, 200	30,700	2.01
				Rice+Pea	**64.25**	**49,000**	**96,200**	**47,200**	**1.96**
2012-13	-	-	**Rice-fallow** (var. Shahsarang) (*Monocropping*)		**37.25**	**19,250**	**37,250**	**18,000**	**1.94**
	10	**4.5 ha**	**Rice- Pea** *(Zero tillage)*	**Rice** (var.Shahsarang)	38.00	20,000	38,000	18,000	2.00
				Pea (var. Arkel)	31.65	31,500	76,125	44,625	2.42
				Rice+Pea	**69.65**	**51,500**	**1,14,125**	**62,625**	**2.22**
2013-14	-	-	**Rice-fallow** (var. Shahsarang) (*Monocropping*)		**38.15**	**19,850**	**38,150**	**18,350**	**1.92**
	25	**7.25 ha**	**Rice- Pea** *(Zero tillage)*	**Rice** (var.Shahsarang)	38.80	20,000	38,800	18,800	1.94
				Pea (var. Arkel)	32.75	33,250	81,900	48,650	2.46
				Rice+Pea	**71.55**	**53,250**	**1,20,700**	**67,450**	**2.27**

2014-15	-	-	**Rice-fallow** (var. Shahsarang) (*Monocropping*)		**39.23**	**20326**	**39230**	**18904**	**1.93**
	30	**9 ha**	**Rice- Pea** *(Zero tillage)*	**Rice** (var.Shahsarang)	39.2	21,750	39,200	18,450	1.8
				Pea (var. Arkel)	34.8	33,500	87,000	51,490	2.59
				Rice+Pea	**74**	**55,250**	**1,26,200**	**69,940**	**2.28**

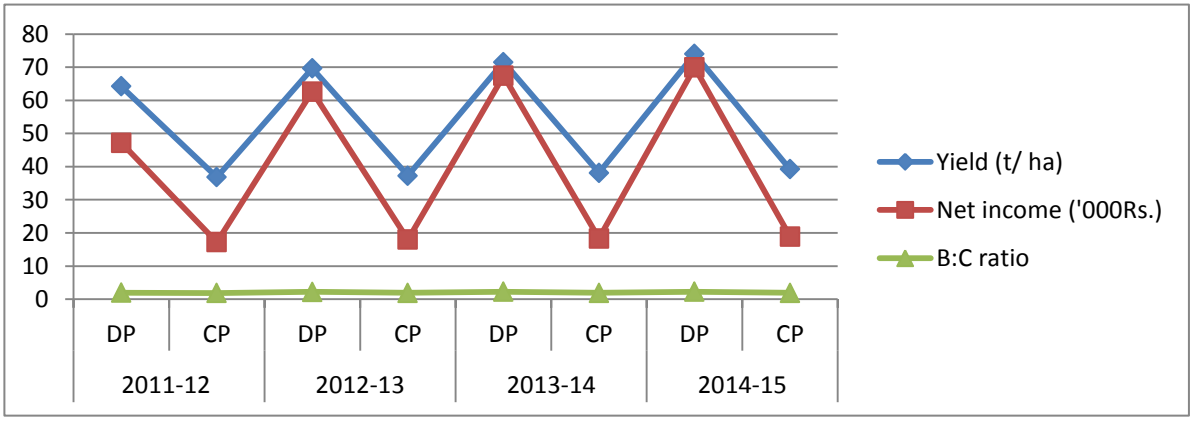
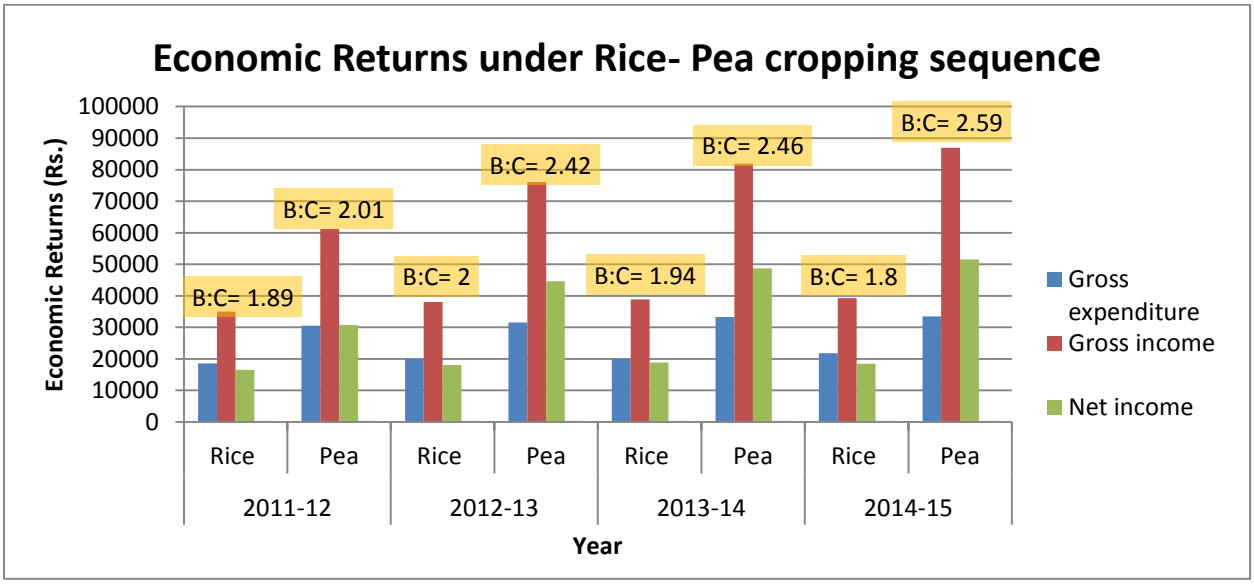


Fig 7.Good Crop of Pea under zero tillage

Fig 8. Zero-tillage Pea



Horizontal spread of the technology:

The successful demonstration of this climate resilient No-till cultivation technology under NICRA (Technology Demonstration) component of ICAR Research Complex for NEH Region, Meghalaya was realised by following the principles of "learning by doing" and "seeing is believing". Prior to the intervention of this technology; the rice fields in Nongthymmai village usually remain fallow without growing any second crop after rice. But after the successful intervention of this technology, farmers of the village could think of growing rabi pulses like pea successfully after Kharif paddy instead of keeping the rice field fallow during rabi season. The successful adoption of this no-till cultivation of peas could create an impact among the members of the Nongthymmai Development Society to go for extensive adoption of the technology for better income generation from agriculture. The farmers of the village used to sell their produce in local mandi and Shillong Bara Bazaar that fetched a good market price of their produces. The impressive performance of No-till demonstration of Peas conducted in Nongthymmai village awakened the farmers, farm women, rural youths of the same village as well as neighbouring villages namely Klew, Nongpyrdet, Mawnohsynrum and Mawkyrdep, Tyrso and Patharkhama to adopt this resilient technology under climate change adaptation and mitigation to go for second crop after paddy as it helps to increase the cropping intensity and elevate net income. Moreover, this technology was also found to be a better reconciliation under the climatic stress condition.

Fig 9. Zero-tillage training-cum- demonstration at Tyrso village

Fig 10. Zero-tillage demonstration at Patharkhama village Jirang

Impact of the No-till cultivation:

The rice- pea cropping sequence under no-till system enhanced the cropping intensity of the area to the tune of 150-155% with a substantial income enhancement of Rs. 29,995/- (2011-12), Rs. 44,625/- (2012-13), Rs. 49,100/- (2013-14) and Rs. 51036/- (2014-15) over the rice- fallow (monocropping) system, respectively. The successful diffusion of this technology adorned Mr. Stephan Shadap with ***Innovative Farmer Award*** by ICAR Research Complex, Meghalaya and many other recognitions in different forums.

Acceptance of the technology by the farmers:

The farmers of Nongthymmai village were highly impressed and motivated by the no-till cultivation practices due to its cost effectiveness, less labour consuming, high energy saving increasing cropping intensity (%) and higher net income with efficient utilization of available resources in the village. In fact, the success of no-till technology empowered the farmers of the Nongthymmai village to put their demand before the state line department for cultivation of *rabi* pulses like field pea, lentil and oilseed crops like mustard/ toria in addition to off-season vegetables in the rice fallow as second crops. Realizing the potential of no-till pea cultivation in rice fallow, most of the Krishi Vigyan Kendras in the state started popularizing the technology in the farmers' field. Under National Food Security Mission (NFSM), the Department of Agriculture, Government of Meghalaya also made planning for popularizing no-till pea and lentil cultivation in large scale particularly in rice fallow land for ensuring food security in the region.

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