

Climate Change Adaptation and Sustainable Livelihoods



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SRT – A CLIMATE SMART, REGENERATIVE, AND CONSERVATION AGRICULTURE TECHNIQUE FOR SUSTAINABLE LIVELIHOOD

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ABSTRACT

Intensive and extensive tillage in modern day agriculture has proved to be a 'degenerative agriculture' practice and is resulting in extreme land degradation. With the factors such as the ever-increasing population and the associated resource burden, land mismanagement, the adverse effects of climate change, the decreasing productivity of the agriculture sector, etc., demand the mankind to adopt regenerative farming, which is sustainable for increasing the productivity. The Saguna Rural Foundation team's efforts since 1998 have ensured the perfection of the Saguna Rice Technique (SRT) which is an agro-practice implemented to achieve climate change mitigation and sustainability. SRT is a Conservation Agriculture (CA), Zero Till method of farming which is climate-smart and essentially a regenerative agricultural practice. The results of adopting and practising the SRT method of farming have improved soil health by increasing soil organic carbon, thus increasing its productivity significantly. Being a zero till method of agriculture, it has reduced labour and costs of inputs for crop cultivation. It is thus the holistic capacity-building tool for today's farmer. SRT is an aerobic method of cultivation, preventing methane emissions, naturally mitigating greenhouse gas emissions. A unique 'Farmers' Happiness Index' survey, conducted by Saguna Rural Foundation, with a sample of 160 SRT farmers, resulted in an 8.58 Happiness quotient on a 0 to 10 scale. The SDGs are a universal call for action to end poverty, protect the planet and ensure people enjoy peace and prosperity. Through successful implementation of SRT, we at Saguna Rural Foundation aspire to ensure 'Doubling of Farmers' Income' and climate change mitigation, and contribute to the achievement of the SDGs.

Keywords: SRT, Regenerative Farming, Conservation Agriculture, Carbon Farming, Zero Till, Capacity Building Tool.



Introduction - Why SRT?

The exponential expansion of service sector industries and the associated rise in income of the people thus employed, have robbed the confidence and dignity of the primary sector professionals, who cite low-income generation as a major cause of concern and are thus shying away from the agrarian sector. With the factors of the ever-increasing population and the associated resource burden, land mismanagement, the adverse effects of climate change, the decreasing productivity of the agriculture sector, to name a few, demand the mankind to adopt precision farming to ensure optimum productivity.

Stephen Hawking, one of the most brilliant minds of this century, had once opined, "the world is coming to a catastrophic end because of two things i.e. food shortage and global warming." The conclusions of the special report by the IPCC (Intergovernmental Panel on Climate Change) is based on the analysis of more than 6000 scientific studies, and have been debated, discussed and determined by

over 91 climate scientists across 40 countries, warning us that we have got as little as 12 years to take action so as to mitigate and adapt to the effects caused by the increasing rate of global warming causing climate change and related ecological and environmental degradation.

The Keeling Curve (Figure1) is one of the most compelling pieces of scientific evidence that shows that carbon dioxide (CO₂) is accumulating in our atmosphere. CO₂ is a greenhouse gas. Greenhouse gases trap heat in the atmosphere and, in turn, warm up the planet. More greenhouse gas molecules in the air means more heat is trapped, leading to an overall warming of the planet. Presently, our globe has 415 ppm CO₂ level while the detrimental level is 450 ppm. With the rising industrialisation, concretisation, and the resultant reduction in the green cover of the planet, all of us, with our collective efforts together, are adding 3 ppm per year, leaving us barely 12 years to breathe comfortably (Monroe, 2019). While the majority of the

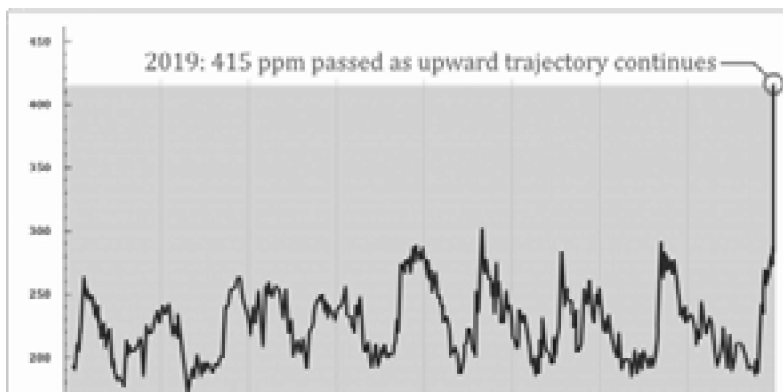


Figure 1: The Keeling Curve (Monroe, 2019)

global warming activities give off carbon dioxide, the agricultural sector primarily emits CH₄ and N₂O. Various methods of irrigation, tillage and soil management lead to the production of N₂O and CO₂, and the use of manure contributes to both CH₄ and N₂O emissions. Clearing space for agriculture (e.g., deforestation) is also a contributor to carbon emissions and land degradation. And, as the World Future Council points out, soil erosion caused by agriculture and natural processes is also a significant cause for ecological concern. Though not directly related to global warming, its impact will be felt more acutely as the climate changes and the amount of topsoil is reduced worldwide. (Nahigyan, 2016)

Analysing various such reports and researches, the world community is eagerly looking for solutions that would answer both the pressing needs of the hour, viz. global warming and food shortage. After the historic Paris Climate Agreement in December, 2015, the then President of the United States of America, Mr. Barack Obama had opined, "we are the first generation to experience the effects of climate change and the last generation to do something about it."

Since 1998, the Saguna Rural Foundation teams' relentless efforts and extensive field experimentations under the immaculate guidance of Krishi Ratna Shri Chandrashekhar Bhadsavle have ensured the perfection of the Saguna Rice Technique (SRT), targeting mitigation of climate change and sustainability of agriculture through climate-smart

agriculture. SRT is a Conservation Agriculture (CA), Zero Till method of farming which is climate-smart and essentially a regenerative agricultural practice.

Over due course of time, it has been empirically observed and has been proved by almost 3000 SRT farmers spread across 16 districts of Maharashtra that SRT technique is both a mitigating tool for global warming as well as a perfect adaptation for sustainable agriculture. It is thus, the holistic capacity-building tool for today's farmer. The sustainability quotient of SRT agro-practice is being recognised and appreciated on national and international platforms, winning Shri. Chandrashekhar Bhadsavle and his Saguna Rural Foundation, the WatSave Farmer Award 2016, Earth Care Award 2016, Krishi Ratna and Krishi Bhushan, to name a few. The SRT method of farming has also been nominated as a 'best practice of sustainable development' as propounded by Deen Dayal Upadhyaya Antyodaya Yojana.

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call for action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. Through successful implementation of SRT, the team of Saguna Rural Foundation aspires to ensure 'Doubling of Farmers' Income' and climate change mitigation, contributing to the achievement of the Sustainable Development Goals.



The Science of SRT

As has been proven, carbon dioxide (CO₂) is the most prevalent greenhouse gas in our atmosphere. When more carbon and other greenhouse gases are added to the atmosphere, more heat gets trapped. The addition of excess greenhouse gases is rapidly changing our global climate, destabilising weather patterns, and disrupting ecosystems everywhere. We are carbon-based life forms. Carbon is the key component of all life. It would be impossible for life on earth to exist the way it does without carbon. It is the main component of sugars, proteins, fats, DNA, muscle tissue, and almost everything in our body and other life forms on the planet. Unlike aerosols or other toxic chemicals, carbon is not a pollutant. However, too much of it in the wrong place can be highly destabilising. Earth's five 'carbon pools' are the soils, oceans, atmosphere, biospheres and fossils. Carbon flows between these pools in an exchange called the carbon cycle. Any change in the cycle that shifts carbon out of one pool, but naturally, puts more carbon in another pool. The evolutionary development of plants fixing carbon through photosynthesis is complex and has occurred over a long period of time. Plants evolved from a group of green algae as early as 500-700 million years ago. The process of photosynthesis evolved in the oceans much earlier, around 3.4 billion years ago. Land-based plants played a critical role in creating the type of atmosphere we have on our planet today. They create oxygen and remove carbon from the atmosphere, transforming

it into carbohydrates (sugars) which build the biosphere and soil. Over the long term, the cycling of carbon between the five pools maintains a balance that prevents all of Earth's carbon from entering the atmosphere (as is the case on Venus) or from being stored entirely in rocks. This balance helps keep Earth's temperature relatively stable and liveable.

Soil Organic Matter (SOM) is vital to healthy soils. Yet, most modern agricultural operations focus on managing nitrogen, phosphorus and potassium (NPK) and ignore carbon (C). Only half of the original organic matter remains in most modern cultivated soils. In general, SOM levels have fallen from 5 per cent of the soil to less than 1 per cent on most cropland soils. The soil is the largest storehouse of carbon on land. However, an estimated 50 to 70 per cent of the world's cultivated soils lost their original carbon stock when the soils were exposed to higher temperature causing oxidation of carbon to become CO₂.

Factors Hastening Oxidation of Carbon:

- TILLAGE – exposes carbon aggregates and life forms to oxygen, which releases the soil carbon into the atmosphere as CO₂. Tillage also increases vulnerability to wind and water erosion.
- FERTILIZER & PESTICIDE APPLICATION – can cause the release of excess greenhouse gas emissions by killing important organisms that build and maintain healthy soil.
- BARE SOIL – emits more carbon than healthy soil, which is covered by cover crops and living organisms that create



the carbon glues for sequestration.

- OTHER AGRICULTURAL PRACTICES – like clearing forests, uncontrolled grazing, and concentrated production of livestock and their manure can also cause significant greenhouse gas emissions.
- Burning of plant residues and wildfire.

Soil is one of the most important natural resources on the planet. Together with sunlight, air and water, it provides the basis for life today. Soil is a complex mix of minerals, air, water, and countless microorganisms that comes in many types. It is what allows us to grow our food, acts as a water filter, and is host to the greatest concentration of biomass anywhere on the planet. All the carbon in carbohydrates comes from the air. Through photosynthesis, with the help of sun's energy, plants produce simple sugars or carbohydrates. The plants use water (H₂O) from the soil and carbon dioxide (CO₂) from the air and recombine them to form carbohydrates (COH) and oxygen (O₂). These carbohydrates form the basis of the food chain for humans, animals and the soil ecosystem. Living plant roots actively exude sugars into the soil to feed soil microorganisms. In return, these microorganisms provide nutrients to the plants and build the soil. Microbes release resins (carbon glues) which help in soil aggregation, which, in turn, facilitates air and water movements through the soil system.

Increase in SOM promotes plant and soil health, which, in turn, enhances photosynthetic

transfer of carbon dioxide to soil carbon. There are dozens of other common conservation and agricultural practices that can also build and retain soil carbon. The USDA refers to these as "carbon farming" practices. There is also a movement in today's agricultural community to define practices that are 'regenerative' in nature.

Regenerative agriculture is a system of farming principles and practices that increases biodiversity, enriches soils, improves water holding and drainage capacity of the soil. By capturing carbon in soil and aboveground biomass, regenerative agriculture aims to reverse global climate change. At the same time, it offers increased yields, resilience to climate instability, and higher health and vitality for farming communities. (TGI, 2017)

Soil Organic Matter (SOM) is one of the most important aspects of what makes soil healthy. Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans. By regulating water, buffering pollution, providing habitat for microorganisms, cycling nutrients and providing a stable healthy soil structure for plantscrop productivity can be increased even in odd climate conditions making it climate-smart.

Thus SRT, a regenerative method of agriculture, makes sure that carbon is fixed into the soil while production of food, fibre and fuel is in the progress.



Result & Discussion:

SRT has significant positive impacts on farmers, environment, soil and water, along with multiple other benefits. It is one of the techniques that sets up a win-win scenario for everyone. Following are a few key benefits of the technique.

- SRT directly reduces the inputs traditionally considered pre-requisite in crop cultivation methods; positively influences the productivity of the crop, enabling the farmer to realise his/her actual potential by enhanced capacity building, adopted under SRT, which directly results in doubling of farmers income.
- SRT does not need the farmer to engage in ploughing, puddling, transplanting and hand hoeing; hence, the farmer's cost of production is reduced by almost 40 per cent. This also eliminates mental stress for availing skilled labour required for transplanting.
- By elimination of puddling loss of valuable silt is prevented. Thus, more fertile land can be handed over to the next generation.
- Leaves of rice plants on SRT beds seem to be broader and grow substantially higher and upwards to gain more sunlight than their counterparts in the conventional method. They are, hence, likely to produce more biomass - resulting in higher yield.
- SRT eliminates the need for hand hoeing. This reduces hard work and loosening of the top layer of soil, making it resilient to erode.
- Because of the preservation of the biomass and the natural fertility of the soil, SRT reduces the quantity of fertilisers substantially.
- SRT involves the strategic and focused use of general purpose systemic weedicide to trigger the decay of the plant remnants post-harvest. This results in remarkable earthworm growth that feeds on decaying plant parts and enriches the soil with natural elements. The earthworms also result in the soil being aerated. SRT protects the soil and the microbiome, along with the environment, while simultaneously proving to be a financial success for the farmer.
- The traumatic shock caused to the rice seedlings during transplanting is eliminated in SRT. This reduces the possibility of pest & disease prevalence during the growth stages of the crop.
- SRT saves the time required for soil tilling between two crops. Also, SRT rice crop matures and is ready for harvest 8-10 days earlier than the rice crop grown with the use of traditional methods. This leaves valuable 10-15 days of crop season for the farmer enabling him to take more than one crop in the same plot in a year.
- SRT yields a higher percentage recovery of grains during milling of the paddy.

- SRT eliminates the use of heavy agricultural machinery for tilling in the field, which prevents compaction and formation of hardpan of lower strata of soil, enabling better drainage and water infiltration into aquifers.
- Some SRT farmers have realised considerably high returns (more than ₹500,000 per hectare per annum) with crop rotation such as scented rice varieties in Kharif, leafy vegetables in Rabbi and improved groundnut (W-66, Varadan) in summer.
- SRT is the optimal solution in natural calamities such as hailstorms, floods, cyclones, untimely rain-storms, etc., because the crop cycle is shortened and it involves multiple choices of short-term rotation crops such as pulses, vegetables, onions, sunflower, groundnuts, etc.
- Recovery of damaged soil due to lashing, scrubbing and natural calamities can be accelerated by SRT as is proven by observation and research.
- SRT's elimination of all tillage and puddling drastically reduces diesel consumption, and therefore decreases the resulting emission of carbon dioxide and other GHGs over thousands of acres of paddy cultivation. Also, SRT being an aerobic method of rice cultivation prevents methane generation.
- Reductions in carbon dioxide and methane emissions have a direct positive impact on global warming.

Reasons Why Farmers Rapidly Adopt SRT

- The progressive and innovative farmers seem to quickly adopt SRT as they are persistent in their approach to progress through change and experimentation.
- SRT is a precision farming method. Those who follow the SRT protocol are quite successful in adoption.
- Those farmers who understand and take advantage of saving of days between two crops along with reduced costs and treacherous labour make the best use of SRT tool in their lifestyle.
- Those farmers who have a mindset of learning new ideas become the best adopters of SRT.
- Those farmers who exert to take second and third crop on the same land for the advantageous higher income with lot fewer efforts have proved to be the best SRT farmers.
- The farmers who realise that SRT gives them independence from tractor, excess labour and excess water, reap the best benefit of the technique.
- When the farmer notice presence of earthworms in the root zone area of SRT beds and also when they see the uniformly vigorous vegetative growth of the crop, they become very happy and confident.
- Often SRT farmers, who notice double the yield of the crop as if two years' production in one year, become extremely happy.



The detail information on cost of SRT cultivation in comparison with traditional puddling method is presented in Table 1. SRT reduced the cost of cultivation by Rs 7287 per ha and increased the production by 69 per cent

with highly significant profits of additional Rs 38787 per ha.

The number of farmers adopting SRT in different districts of Maharashtra has increased over the years (Figures 2 and 3).

Table 1: Comparative Information of Cost of Production of Rice by SRT and Conventional Puddling Method

Cost items for SRT	Amount Rs (per ha. per crop)	Cost items for Conventional/ puddling method	Amount Rs (per ha. per crop)
Fixed costs for 20 years Ploughing and pulverising of soil by tractor, 5 hr @ Rs. 600/hr = 3000	330	Chopping of forest growth 10 workers @ Rs. 250	2500
Making of beds by tractor, 3.5 hr @ Rs. 600/hr = 2100		Bare minimum cost of forest/own material for burning of "Rab".	1500
SRT frame @ 1500		Stacking material & controlled burning of "Rab" : 2 workers @ Rs. 250	500
General weedicide Glyphosate, 5 Lt @ Rs. 440/- per litre	2200	Ploughing of soil by Tractor 5hr @ Rs. 600 per hr	3000
Improved variety Rice Seed, 20 kg @ Rs. 70/kg	1400	Improved Variety of Rice seed , 38 kg @ Rs. 70/kg	2660
Pre dibbling mixed fertilizer (50kg Suphala @ 850) + Phorate (insecticide) 8kg @ 80	1490	Phorate (insecticide) for Rab 5 kg @ Rs. 80	400
Seed dibbling 25 workers @ Rs. 250	6250	Sowing seeds on nursery	500
Selective weedicide Goal(Oxyflorfen), 600 ml @ Rs. 243 per 100ml	1460	Urea fertilizer for Rab, 2 applications, 76kg @ Rs. 7/kg	532
Gap filling 10 workers @ Rs. 250	2500	Puddling by tractor @ Rs. 600 per hr	1500
Weeding 10 workers @ Rs. 250	2500	Transplanting 38 workers @ Rs. 250	9500
Urea bricket fertilizer 150kg @ Rs. 22/kg	3300	Small jobs in transplanting @ Rs. 250	500
Application of urea bricket 15 workers @ Rs. 250	3750	Mixed fertilizer (18:18:10), 125kg @ 18/-	2250

Cost items for SRT	Amount Rs (per ha. per crop)	Cost items for Conventional/ puddling method	Amount Rs (per ha. per crop)
Harvesting 30 workers @ Rs. 250	7500	Boot stage urea application, 125kg @ 7/kg	875
Total Cost	32,680	Lump sum Labour for all fertilizer application, 2 workers @ 250	500
Production: 5500 kg Price: @ Rs. 14/kg	77,000 Profit = 44,320	Weeding 15 workers @ Rs. 250	3750
		Harvesting 38 workers @ Rs. 250	9500
		Total Cost	39,967
		Production: 3250 kg Price: @ Rs. 14/kg	45,500 Profit = 5,533

Notes:

1. All labour costs are considered @ Rs. 250 per day regardless of gender and region.
2. Labour items in the SRT method have proved to be simple and enjoyable that the whole family enjoys the operations, rather than depending on outside labour.
3. SRT follows precision methods, especially for fertilisers and insecticides.

The performance of SRT, through the analysis of a small sample, is presented below.

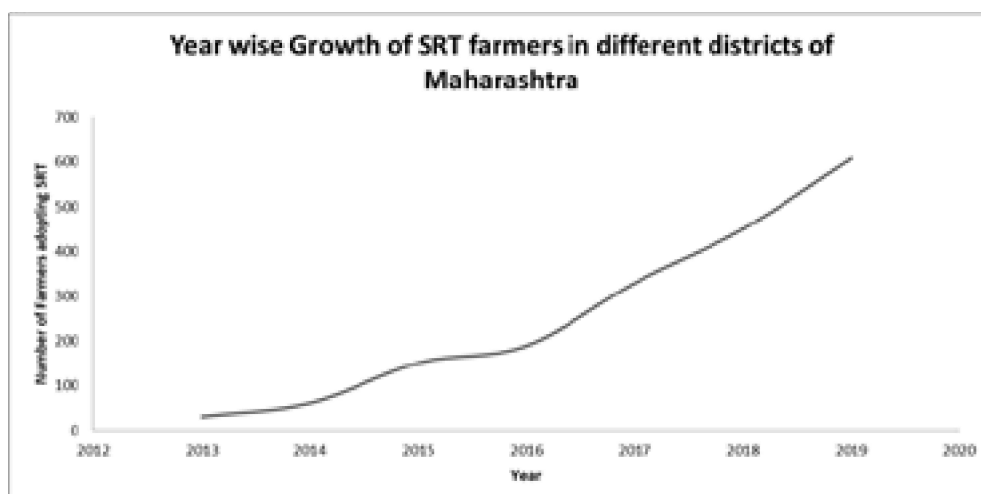


Figure 2: Year-wise Growth of SRT Farmers



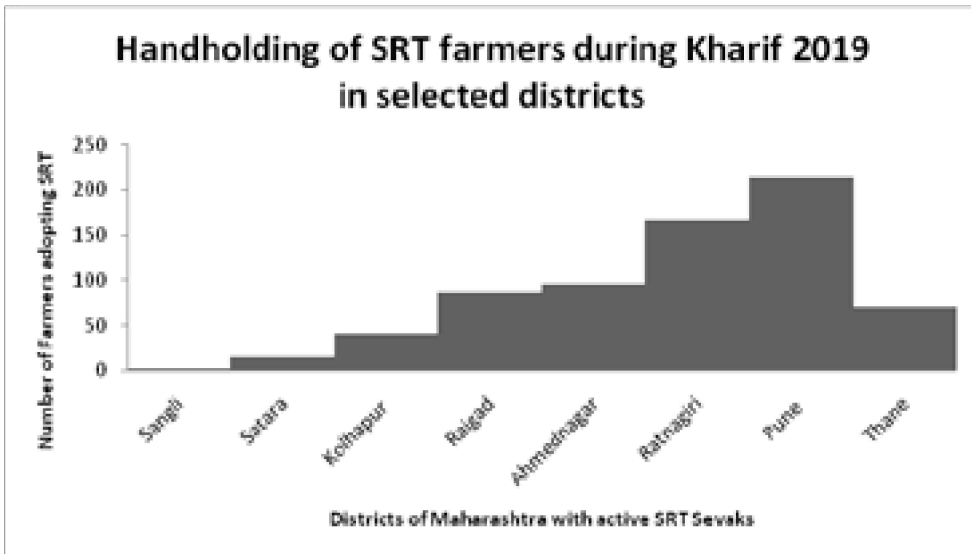


Figure 3: Handholding of SRT farmers during 2019

A unique ‘Farmers’ Happiness Index’ survey (Fig.4), with a sample of 160 farmers, resulted in an 8.58 Happiness quotient on a 0 to 10 scale.

This survey proves that SRT is indeed a very effective method through which an increase in productivity and self – sustainability of the profession of agriculture.

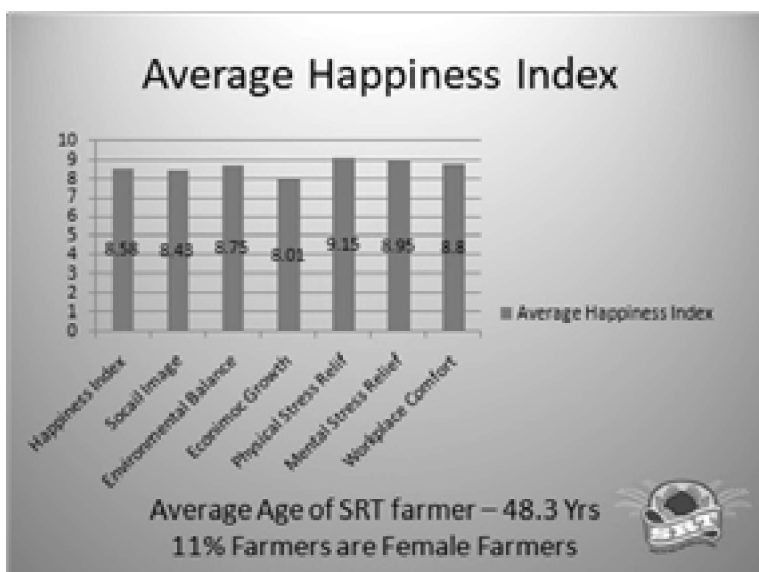


Figure 4: The Farmers’ Happiness Index (Source: Saguna Rural Foundation, 2017)

Conclusion

With the ever-rising number of farmers adopting SRT, at present more than 3000 happy and confident farmers, spread across 16 districts of Maharashtra, are practising SRT. The sustainability quotient of SRT agro practice is being recognized and appreciated on the national and international platforms, winning us the Watsave Farmer Award 2016, Earth Care Award 2016, KrishiRatna, KrishiBhushan, to name a few. The SRT method of farming has also been nominated as a 'best practice of sustainable development' as propounded by Pt. DeenDayalUpadhayaAntyodayaYojna.

The modern-day mechanized way of agriculture, essentially is a 'degenerative method of agriculture', and has not only decreased the natural fertility of the soil but has also exponentially negatively impacted the sustainability quotient of the farmland, depleting the groundwater table and natural aquifers capacity. This is accelerating the impending water scarcity threat and worsening our food security. The incessant rainfall of 2019, that caused massive flooding in the entire state, affected the livelihood of people

the most. Agriculture was hard hit and the Kharif crop is lost for many farmers in the state. The flooding of farmlands and the aftermath of the situation has led us to record a unique observation. Farmers who adopted the Saguna Rice Technique of zero - till, conservation agricultural method of cultivation, not only witnessed minimum crop damage but also acknowledged the sustainability quotient of the cultivation method. SRT farmers opined that despite massive flooding, the land remained intact with the crop and was not washed away, as it happened with traditional farmers. In many cases, the incessant rainfall led to waterlogging of the farmland denying the farmers the opportunity to plant rice saplings.

Farmlands that employed the SRT cultivation method are not only content with their efforts but are also proving the fact that the SRT technique is both a mitigating tool for global warming as well as an adaptation method that follows a sustainable agricultural methodology. It is thus, the holistic capacity-building tool for today's farmer.



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