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CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA

An Dinh Co. Ltd.

866 Bach Dang, Ha Noi, Viet Nam; Dong Xuyen commune, Tien Hai district, Thai Binh province Vietnam

Agriculture

www.andinh.com.vn

Pathway to a low-carbon cultivation: New rice farming practices to reduce GHG emissions and improve yields in Thai Binh province of Vietnam

Business Spotlight

An Dinh Technology Development and Investment Co. Ltd. (hereafter An Dinh) is the largest producer, trader and exporter of high-quality rice products in northern Vietnam. The core business philosophy of An Dinh is to supply high-quality rice with a clean agricultural process, well-controlled use of fertilisers and irrigation water and without harmful pesticides. In 2017, An Dinh initiated a new rice-farming method to reduce GHG emissions and improve yields in Dong Xuyen commune, Tien Hai district, Thai Binh province. The method comprises optimised scheduling of required inputs and activities to grow the DS1 rice variety, and includes specific requirements for planting density, flooding and draining, fertiliser use, and rice stubble and straw residue management. The adoption of these emission-reducing farming practices resulted in:

- an increase in rice yield of 15–20%
- an increase in rice revenue for the rice farmers by 7%
- a reduction of GHG emission by 60%
- a reduction of fertiliser use by 40% (by volume) and 3% by cost.

From a small pilot area of 0.2 ha cultivated in 2017, these practices are now being widely adopted across 2500 ha in Thai Binh and other provinces of Vietnam with the participation of more than 6000 rice farming households. An Dinh won the second prize worth USD 400,000 in the AgResults Vietnam Challenge Project in 2021 for performance relating to yield increases, GHG reduction, and uptake and replicated technology use by farmers.

Keywords

Emissions-reducing rice farming practices, Greenhouse gas

Innovation

Manufacturing, Resource efficiency

Analysis of An Dinh Technology Development and Investment Co. Ltd. (Vietnam)

Context and baseline

Agriculture is an important pillar of the Vietnamese economy. Rice farming involves two-thirds of the country's rural labour and produces 30% of the country's total agricultural production value. Vietnam is the third largest rice exporter in the world. Rice production in Vietnam is by far the second-highest emitting sector of greenhouse gases, accounting for about 19% of total national emissions (in 2020). About half (48%) of agricultural sector emissions and over 75% of methane emissions come from rice cultivation. Many factors contribute to GHG emissions in Vietnamese rice production, including inefficient use of water for irrigation, very high seeding density, high and inefficient fertiliser application rates, extensive use of different rice varieties on the same area leading to ineffective pesticide control and watering, improper management of rice residues such as rice straw and husks, and inefficient energy use in agriculture overall. Traditionally, rice is grown in flooded conditions, so that the water blocks oxygen from penetrating the soil, which creates the ideal conditions for anaerobic bacteria to thrive on decomposing organic matter (mainly rice straw residue) and release methane, a powerful greenhouse gas (GHG). Poor absorption by the rice plants of nitrogen-based fertilisers, often overused by farmers, further leads to nitrous oxide emissions, another powerful GHG.

Farmers are unlikely to change their practices just to reduce emissions. Thus it is crucial to link emission reductions to benefits that accrue directly to the farmers themselves, such as higher yield or an increase in income. Inspired by the prospect of simultaneously increasing smallholder farm yields and reducing GHG emissions through good farming practices, An Dinh initiated its new rice farming method in 2017 to transition to low-carbon rice cultivation in Dong Xuyen commune, Tien Hai district, Thai Binh province of Vietnam.

Innovation

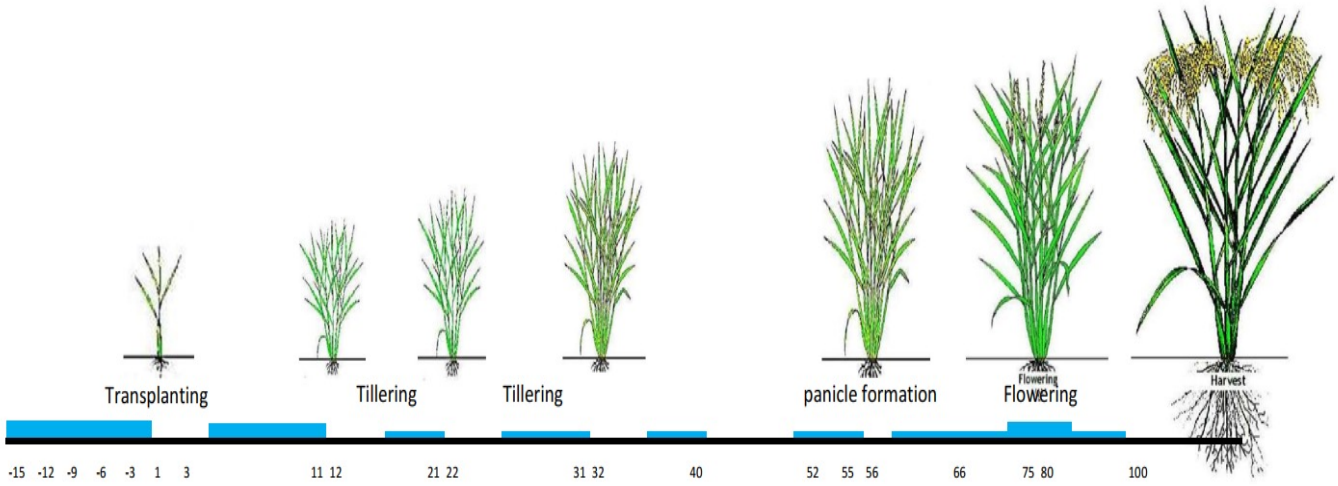
The new rice farming method developed by An Dinh consists of the following innovations in rice cultivation, including the management of irrigation, fertilisation, harvesting and residues.

Planting density. Because methane and nitrous oxide are released through rice stalks, one way to reduce GHG emissions is to have fewer rice stalks and more tillers of rice from each stalk instead. The planting density was therefore reduced to 18–20 rice stalks per m^2 compared to the traditional 40 rice stalks per m^2.

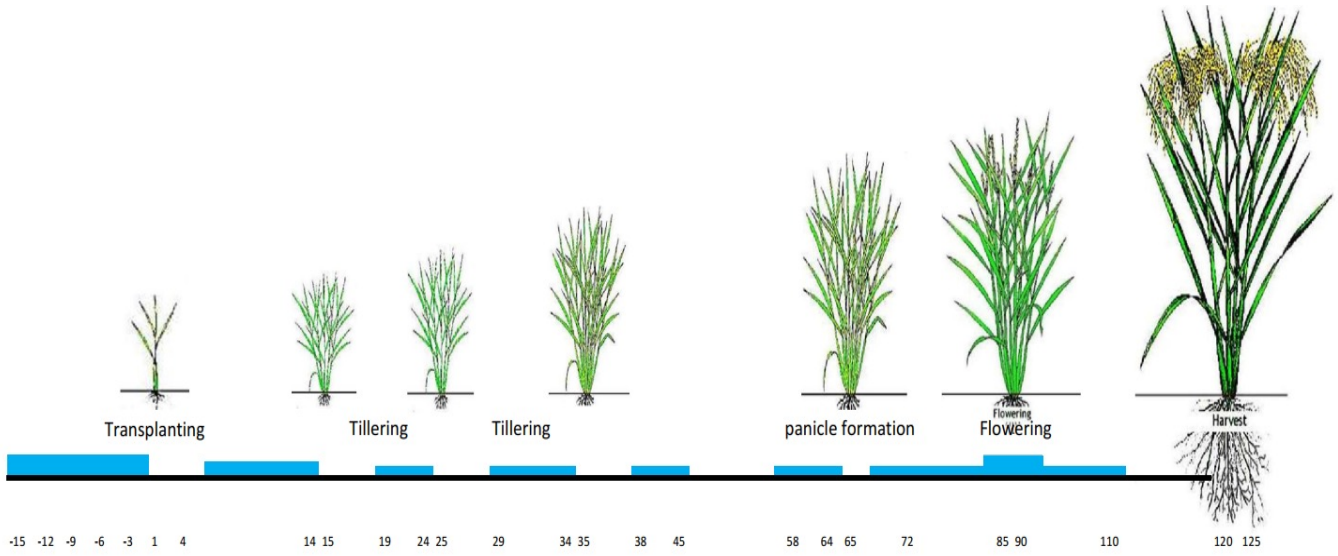
Water management. Flooding and draining schedules following alternate wetting and drying (AWD) practices reduce the build-up of anaerobic methane-producing bacteria in flooded fields. With training provided by An Dinh, farmers use appropriate AWD schedules (see Figures below) so that rice plants are flooded at the times when the plants require more water for growth and stability, and they are kept dry when flooding is not required for growth, which curtails anaerobic soil bacterial activity and thereby minimises the formation and release of methane and nitrous oxide. AWD also prevents the dilution of pesticides and fertilisers on drying fields that are not flooded, increasing effectiveness.

Fertiliser use. Reducing the application of nitrogen fertiliser reduces soil nitrogen and thereby nitrous oxide emissions. Although some amount of nitrogen is necessary to achieve adequate rice growth, overuse of nitrogen fertiliser can be prevented with 'slow-release' fertilisers. These fertilisers have a coating that wears off in sunlight or water over time, enabling more efficient uptake of nitrogen. The fertilisers are more expensive, but they do not require as many applications. This method is combined with training farmers to improve their understanding of the necessary amounts of nitrogen and the interactions with other nutrients such as phosphorus and potassium, equally necessary for rice growth. Moreover, farmers can apply less fertiliser more frequently so it is used more efficiently by the plants, rather than over-applying to account for decreased availability and washing off over time.

Crop residue management. Management of rice stubble and straw residue also has an effect on GHG emissions. An Dinh applies enzymes to the land to accelerate the decomposition of crop residues during the intercropping period. Aerobic decomposition of straw and stubble in the field does not generate methane and it also stores carbon in the soil, which in turn improves yields and prevents the accumulation of organic material that would otherwise decompose anaerobically during the next crop cycle to release methane. Another option is to remove the residue from the field entirely, either to decompose aerobically or to be used for other purposes such as mushroom growing substrate, composting, or manufacturing brooms.



Controlling water and fertiliser in the summer crop



Controlling water and fertiliser in the spring crop

Circular Economy impact

The new rice farming method contributes to circular economy principally through the improved efficiency of fertilisers, water (and associated energy requirements) and reduced generation of agro-residue waste, i.e. through resource efficiency in rice farming practices. This is particularly effective in minimising the generation and release of methane and nitrous oxide, two powerful greenhouse gases. The new method is effective in reducing GHG emissions in rice production by 60% compared to traditional methods through the synergistic changes in planting density, irrigation, fertilisation and crop-residue management.

Planting density. Lower planting density increases branching ability, giving more tillers of rice for each stalk, and it also improves photosynthesis to remove CO_2 from the air and produce more oxygen. Fewer stalks also reduce methane and nitrous-oxide emissions, as these are released through the rice stalks.

Application of AWD (alternate wetting and drying). Using water properly can increase the drying time of rice fields from 15–20 days to 40–50 days, thus limiting soaking time (anaerobic environment) and reducing GHG emissions in the same process, especially CH_4 and N_2O in the branching stage.

Proper fertilisation (the right technique at the right time) helps reduce fertiliser use by 30%–40%, and the resulting reduction of over-fertilisation lowers N_2O emissions.

Crop residue. Instead of burning straw, which adds to local air pollution, farmers convert the residue to compost or accelerated aerobic decomposition in the field, which in both cases can increase carbon content and quality, and thus reduce methane formation and emissions from anaerobic decomposition during the next wet period of the next cropping cycle.

Business and market impact

The economic impact of adopting the new method of rice farming by An Dinh is remarkable in terms of yield, price, and revenue to the farmers. Yield is a key outcome to measure the success of any new rice-farming method. The average yields for farmers adopting the new method were 5.6 MT/ha. For plots where low-carbon rice technology was applied saw 15%–20% higher yields compared to the matched comparison group. The average rice revenue per sao (plot of 360 m^2) for farmers who adopted the new method was 7% higher than that of the comparison farmers – 730K VND (~ 27.0 EUR) vs. 685.5K VND (~ 25.3 EUR), and the price of rice per kilo was 21% higher because of the high quality of rice.

Estimated average costs and revenue outcomes ('000 VND)

	Rice Variety	Seed cost per sao	Fertiliser cost per sao	Rice sale price per kg	Rice revenue per sao
Summer rice crop season 2020					
Adopter	DS1	36	212	8.07	680
Non-adopter	DS1	43	190	6.53	651
Spring rice crop season 2020					
Adopter	DS1	38	191	6.31	780
Non-adopter	DS1	36	224	5.39	720
Average					
Adopter	DS1	37	201.5	7.19	730
Non-adopter	DS1	39.5	207	5.96	685.5
Change		**94%**	**97%**	**121%**	**107%**

Stakeholders

The new rice cultivation method created benefits not only for An Dinh but for other stakeholders as well. Farmers appear to be more consistently positive about continuing to apply the new method because of the numerous benefits resulting from the different aspects of the system, including reduced expenditures, reduced labour requirements, improved quality and yields, and favourable prices. They also received training and fertiliser subsidies to facilitate the correct application of the technology. From a small pilot area of 0.2 ha in 2017, the new farming method developed by An Dinh has been widely adopted across 2500 ha in Thai Binh and other provinces of Vietnam with the participation of more than 6000 rice farming households in 2023.

Implementation

In 2017, a new rice farming method was first introduced in Dong Xuyen commune, Tien Hai district, Thai Binh province of Vietnam by An Dinh, with the support of the AgResults Vietnam Challenge Project. It was piloted with a small area of 0.2 ha. All investments, the seeds and fertilisers, and training were covered by An Dinh. An Dinh also signed the contract with a biotech company for a technology transfer for the use of enzymes for crop residue management.

The new rice farming technology to reduce GHG emissions developed by An Dinh has been reviewed, updated and adjusted annually to adapt to changes in weather, rainfall, regional climatic condition and rice variety.

An Dinh has expressed the intent to continue actions to promote the low carbon rice cultivation method because it is closely integrated and consistent with the company's core business activities, namely the procurement of specialty rice. Mr. Nguyen Thanh Nhi, CEO of An Dinh, has indicated that the new farming method implemented in Thai Binh province is in line with the goals and strategy of An Dinh, and that they intend to produce high-quality rice on a large scale to target high-end markets such as the EU, the US, Japan and others. With the GHG-reduction technology developed by An Dinh to control fertilisers, and by using plant protection chemicals to meet international export standards, the company will be in a favourable position to expand their business opportunities worldwide.

Takeaways

- Transitioning to low-carbon rice cultivation was made possible by focusing on the specific aspects of rice cultivation practices that release GHG emissions, and then developing agronomic practices to address the root causes of the formation and release of methane and nitrous oxides in particular during the rice cultivation cycle.
- The participation of the farmers and their buying into the process, depend on demonstrable co-benefits of low carbon rice farming, in terms of yield, quality and costs. This is because farmers, and in particular smallholder farmers, cannot be expected to risk their incomes and livelihoods for the sake of achieving lower GHG emissions.
- The new rice farming method pioneered by An Dinh has proved to be a viable option to increase farmer yields and their incomes, improve water use, and reduce GHG emissions from rice cultivation. The method offers a potential upscaling at the farm level, aligning with global and national sustainable development goals.
- Actions to encourage farmers to adopt new rice farming methods are being implemented by An Dinh, including raising public awareness on new rice farming methods by providing high-quality information and training, and by enhancing technical assistance to the farmers.

Acknowledgements

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