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Effectiveness of capacity development programme on mechanical harvesting of paddy as a climate-smart agriculture practice with agro-advisories

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Abstract
One of the most vulnerable agro-ecosystems to climate change is the paddy production system. Extreme weather events like floods, droughts and storms during harvesting stage of paddy can all cause considerable damage to paddy crops, resulting in lower yields and greater post-harvest losses with serious consequences for food security and sustainable agriculture. Therefore, there is need of adoption of climate-smart agriculture (CSA) practices to overcome the climate change challenges faced by framers. Capacity Building programmes (CBP) to the farmers on advanced agricultural techniques are essential for upgrading the knowledge of the farmers. The present investigation was aimed to assess the effectiveness of the CBP on mechanical paddy harvesting as CSA practice in combination with mobile agro advisory for reducing post-harvest losses caused by uncertain rainfall during harvesting operations. The study comprised of 125 randomly selected farmers. The result showed that the level of awareness and adoption of mechanical harvesting as a climate-smart agriculture practice were 62.4% and 48% respectively among farmers and varies with gender, age, education and land holding capacity of framers. Further, 56% of the farmers expressed their satisfaction with the agro advisory communicated during paddy harvesting season by KVK which helped in planning either taking up timely harvesting or postponing certain operations at times of unfavorable weather conditions. Farmers, who adopted mechanical harvesting noted increased yields, decreased post-harvest losses and a slight change in income level. The study also identified some challenges faced by farmers in adopting mechanical harvesting including high costs, lack of access to finance and limited availability of the technology. Study concludes that there is a positive impact of capacity building programmes with dissemination of agro-advisories on farmers' technological knowledge and adoption. This would help to improve the livelihood and food security as well as enhance the resilience of agricultural systems to climate change.

Keywords: Climate change, climate-smart agriculture (CSA) practices, mechanical harvesting, mobile agro advisory, awareness level

1. Introduction
Agriculture is one of the most susceptible sectors since it is naturally sensitive to climatic fluctuations. According to the United Nations Framework Convention on Climate Change (UNFCCC) defined "Climate change" as a change which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere. It is characterized by rising temperatures, changes in rainfall patterns, more frequent extreme weather events and sea-level rise which has a direct impact on agriculture in terms of production, farming methods, environmental implications, rural space and adaptability. According to Adebayo *et al*. (2012) [1], the majority of farmers (95%) claimed that climate change has negatively impacted their farming activities, decreased crop yield and caused a shortage of water and animal biomass over the past ten years due to low rainfall and frequent dry spells whereas only 5% of the respondents said that they have not been impacted by climate change in recent years. The concept of climate smart agriculture (CSA) emerged in the context of climate change as a potential strategy for ensuring food security for the growing world population. The Food and Agriculture Organization of the United Nations (FAO) defines CSA as "An integrated approach that seeks to address climatic fluctuations challenges by promoting agricultural practices that sustainably increases productivity, strengthens resilience, reduces greenhouse gas emissions and enhances achievement of national food security and development goals." It is not just limited to set of practices that can be universally applied. Rather, it is an approach that involves multiple elements in accordance to local contexts and cultural and social sensitivities into account and ultimately listens to the local community about the approach that

best fits their reality. For instance CSA practices, approaches and technologies including minimum tillage, various crop establishment techniques, fertilizer & irrigation management, residue management that can helps to increase crop yields as well as reducing greenhouse gas (GHG) emissions from agricultural activities. In a similar vein, using better seeds, rainfall harvesting (RH), ICT-based agro-advisories and crop/livestock insurances can all assist farmers in lessening the effects of climate change and variability. CSA options combine cutting-edge and traditional technology techniques and services that are pertinent for a particular location lessen the effects of climate change and provide opportunity to endure such changing conditions. Jagadeesha Naika *et al*., (2022) [2], reported that Information and communication technologies (ICTs) can minimize climate change impact on farm livelihoods through timely location specific weather and agro-advisories.

Paddy is one of the most significant crop that causes and contributes to climate change. Each growing season, 144 million smallholder rice farmers face threats to their livelihoods from drought, flood, seawater and excessive temperatures that destroy harvests (https://www.irri.org). According to projections, 2.5 °C to 4.9 °C increase in temperature in India will result in a 32% to 40% decrease in rice yields and 41-52% decrease in wheat yields. GDP would decrease as a result by 1.8% to 3.4% (Rupan R. *et al.*, 2017) [4]. The location, type of crop, and the intensity of the climate change impacts are some of the variables that affect the percentage of post-harvest losses during harvesting. A study of post-harvest losses in India, calculated 10.3% increase in paddy harvesting losses as a result of delayed harvesting caused by inadequate harvesting equipment (Kannan E. *et al.*, 2013) [5]. According to Samson and Duff (1973), delaying harvest by 5, 7 and 10 days each caused 3, 6, and 11% reduction in rice yield. Chavan *et al.* (2015) [13] reported that sickle harvesting is more laborious than mechanical harvesting with reaper. Mechanical harvesting needs 50% less labor than manual harvesting in wheat crop. They also suggested that harvesting losses can be reduced 50% by using mechanical harvester compared with manual harvesting. Additionally, frequently rains and storms during harvest season, seriously damaging standing crops. Unseasonal rains can dampen the matured crop before harvesting and result in mould growth, which may later reduce the grain quality, cause some of the grain to be discarded and increase the associated risk of aflatoxin or other mycotoxin contamination (Hodges *et al.*, 2014) [7].

Farmer awareness cum training programs on advanced climate smart agricultural techniques for mitigation of hazardous impact of climate change are essential for enhancing their knowledge level and capacity development of farmers. Many of the approaches and procedures for adapting to climate change in agriculture are already well-known and in use by farmers as a result of educational training programs. According to Chegere (2017) [8], there is a strong correlation between "good" post-harvest handling methods and fewer post-harvest losses in maize. These procedures include timely harvesting, proper immediate handling and sorting maize, proper drying and application of storage protectants. The same study showed that small-scale farmers may reduce corn storage losses cheaply by using airtight bags in together with training. Several studies reported that, the ability of farming communities to address climate and market risks in agriculture is facilitated by the timely availability of information on weather forecasts, value-added agricultural advisories such as climate information-based input utilization and crop management methods and market information (Magawata 2014; Shaik *et al*., 2011; Singh and Meena 2012) [9, 10, 11].

In the Maharashtra district of Palghar, paddy is the most significant food grain crop. The district's paddy farmer's expreinced that the unpredictable rains during harvesting operations causes higher post-harvest losses and is a significant burden for them as they don't have enough knowledge about the modern harvesting technique as well information related to weather forecast. Paddy harvesting is mainly performed manually, which is a highly labor intensive and slow process. Therefore, it is very important to understand of climate change, its impact and thereby adoption techniques must be identified in order to deal with the current changing environment. To address the aforementioned issue, KVK identified mechanical harvesting as a climate-smart agriculture technique combined with agro-advisories and undertook several capacity building programs to promote it among framers. Therefore, present study was aimed to investigate the impact of training programmes on mechanical harvesting as a climate-smart agriculture practice combined with agro-advisories in terms of awareness level, adaptability and challenges faced by framers for its adoption.

2. Materials and Methods

2.1. Description of the Study Area

The Palghar district comprises of eight blocks namely Jawhar, Mokhada, Vikramgad, Talasari, Vasai, Palghar, Dahanu and Wada having 1008 villages and house hold size is 5-6. The present study was conducted in total 40 villages of Palghar district as the part of Front Line Demonstration (FLD) programme from the year 2017-18 to 2021-22. The villages which were within 10 Kilometer distance and between 10-70 kilometers from the KVK office were selected.

2.2. Methodology

The current study was a five-year long-term study with the goal of raising awareness about climate change and mitigating its effects using crop, location-specific techniques among the framers from the district. In the first stage of study, various On & OFF campus capacity building training cum method demonstration programme, videos show, exposure visits, group discussion, field day group meetings were conducted in the selected villages from the district Over a five-year period, thirty capacity-building programs on climate change and mechanical paddy harvesting as a Climate-Smart Agriculture Practice were implemented, involving 986 farmers. The training program was designed to raise awareness among framers about the use of Self-propelled Vertical Conveyor Reaper for Paddy Harvesting and to encourage farmers to adopt this mechanical harvesting technique as a Climate-Smart Agriculture Practice, in addition to providing Agro-Advisories. Self-propelled Vertical Conveyor Reaper make of Kerala Agro Machinery Corporation Ltd (KAMCO) 3.5 HP (Model: KR 120) was used for demonstration of the paddy harvesting at framers field.

In second stage of the study, Whatsapp groups of framers were formed as a result of their involvement in capacity building programs. Framers were also linked to the m-Kisan Portal. District-level Agro-Meteorological Unit (DAMU) has been established in KVK Palghar during the year 2019. Every Tuesday and Friday, the DAMU of KVK receives weather forecasts from India Meteorological Department on rainfall, maximum and minimum temperature, wind speed, wind direction, cloud cover, maximum and minimum humidity. The subject matter specialist prepares agricultural advisories every Tuesday and Friday once the forecast is received. The agro advisory messages were communicated to the farmers through what's app group, radio, newspapers etc. The weather based agro advisory bulletin contains weather forecast information for the next four to five days, crop status, crop management options with reference to expected weather forecast. Thus, farmers can decide on crop management options such as application of nutrients and plant protection chemicals and strategies to overcome other problems. When there is an occurrence of uncertain rainfall during agricultural harvesting activities, specific agro advisories are issued.

In third stage, the survey of 125 randomly selected framers who received field training about the study objectives was conducted in the month of March 2022. Structured questionnaires were used to collect data. A fully structured questionnaire was used to collect data on their level of awareness of mechanical harvesting as a climate-smart agriculture practice, the impact of agro-advisories on farmers' awareness and adoption of mechanical harvesting and the challenges and factors that influence their decision to adopt this technology. The collected data was analyzed using descriptive statistics, such as frequencies and percentages to describe the level of awareness and adoption of mechanical harvesting.

3. Result and Discussion

3.1. Socio-Demographic Profile of the Farmers

A Socio-Demographic profile of the respondents is presented in the Table 1. The study shows the majority of respondents (88%) were male farmers while the rest of them (12%) were females. Furthermore, the majority of them (91.2%) were married. As this clearly shows, the majority of trainees participating in the training program are married men. The age groups were divided into three categories: the majority of farmers (43.2%) were between the ages of 35 - 48, 31.2% were between the ages of 21- 34 and the remaining (25.6%) were between the ages of 49 - 62 (Table 1). This indicates that the majority of respondents were within active working age. The majority of the trainees (35.2%) have only a secondary education while the remaining 25.6% have a bachelor's degree or above. Illiteracy was found in only 2.4% of framers. This clearly showed that respondents have the fundamental education required to get knowledge about new agricultural technologies related to farming. Nearly about 40.8% of respondents were involved in farming operation, while 38.4% doing their own farming business with farming activities. Table 1 represents the 40.8% farmers have less than 2.5 acre of land while 33.6% framers belong the small land holding category.

Table 1: Distribution of respondents according to their profile

Sr. No	Socio-Personal Characteristics	Category	Respondents	
			Number	Percentage
1	Gender	Male	110	88
		Female	15	12
2	Marital Status	Married	114	91.2
		Unmarried	11	8.8
3	Age	Young 21 - 34 years	39	31.2
		Middle 35 – 48 years	54	43.2
		Old 49-62 years	32	25.6
4	Education	Illiterate	3	2.4
		Primary (1 to 4)	3	2.4
		Secondary (5 to 10)	44	35.2
		senior secondary (11- 12)	30	24
		Graduation	32	25.6
		Post-Graduation	13	10.4
5	Occupation	Agriculture	51	40.8
		Agriculture + Service	26	20.8
		Agriculture + Business	48	38.4
6	Type of family	Nuclear	79	63.2
		Joint	46	36.8
7	Land holding (Acre)	Marginal (< 2.5 Acre)	51	40.8
		Small (2.5-5.0)	42	33.6
		Semi Medium (5-10)	25	20
		Medium (10-25)	6	4.8
		Large (>25)	1	0.8

3.2. Awareness among farmers about Mechanical harvesting as Climate Smart Practice

The degree of knowledge regarding mechanical harvesting as a Climate Smart Practice among paddy farmers can vary depending on their gender, age, education and land holding capability etc. It is crucial that farmers have knowledge about a technology before determining whether to adopt or to reject, a climate change adaptation or mitigation technology. In the present study, all of the respondents claimed that they understood the need of using a paddy reaper for harvesting in order to combat climate change. The distribution of respondents according to their awareness about mechanical harvesting of paddy related to climate change presented in the Fig. 1. Nearly about 62.4% respondents were fully aware about benefits of climate-smart practices are likely to have a good understanding of how mechanical harvesting can contribute to sustainable agriculture. They might actively seek out information on climate-smart practices and incorporate these practices into their farming operations. However, 28% and 9.6% respondents were moderately aware and somewhat aware about mechanical harvesting respectively.

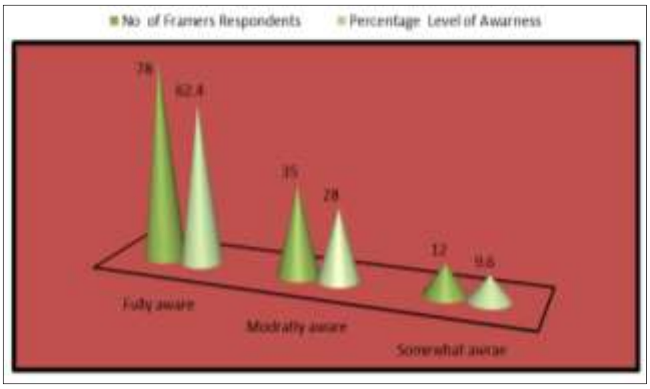

Fig 1: Distribution of respondents according to their awareness level (N=125)

3.3 Adaptation of Mechanical harvesting as climate Smart Practice by Farmers

Adaptation to climate change simply means adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities (IPCC, 2001). The main aim of adaptation is to minimize the vulnerability and enhance the adaptive capacity or resilience of people whose livelihoods are basically dependent on natural resources. In order to respond and cope up to the changing and difficult climatic conditions in agriculture sector adaptation needs to use good agricultural practices.

In present study, respondent farmers revealed their experience that since last seven to ten years they faced major challenges in harvesting operation as occurrence of uncertain rainfall. Hence, often rains and storm occurs causing considerable damage to standing crops. It was observed that, near about 48% framers were realized the benefits of the paddy reaper and adopted the mechanical harvesting practice strategy against changes in the climate. Near about 2% framers purchased paddy reaper while 20% framers used paddy reaper for harvesting on custom hiring basis. Total 65 (52%) respondents are still using manual harvesting practice which is vary laborious as well as time consuming. The initial high cost of paddy reaper and small land holding may be the major obstacle against the required scale of adaptation. Alhassan *et al*., (2018), who reported that farmers in Northern Ghana had a high level of awareness of climate adaptation practices and this, can influence adoption positively.

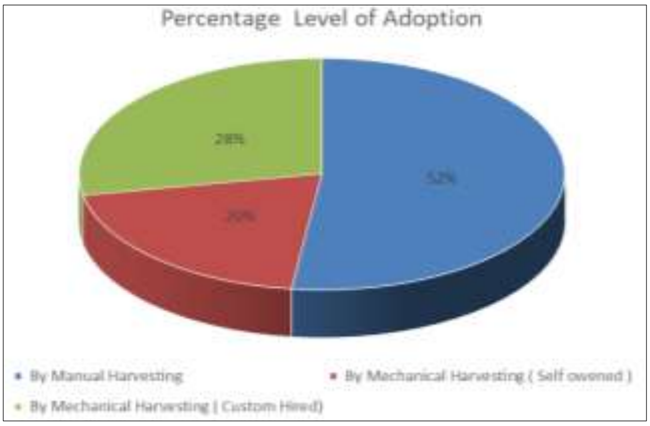

Fig 2: Adaptation of Mechanical harvesting as climate Smart Practice by Farmers

3.4. Usefulness and Impact of Agro – Advisory Service

With the upcoming modernization in all sectors under subsistence culture would certainly require a proper resource based agro- advisory approach to support farming community to regulate their agricultural activities accordingly which enhances their farm income. It was observed that, 56% framers expressed their satisfaction with the current Agromet Advisory Bulletin system which is issued biweekly. They also reported that, the advisory on weather forecast communicated during paddy harvesting season by KVK helps in planning either taking up timely harvesting or postponing certain operations at times of unfavorable weather conditions. It was found that 58.4% framers adopt mechanical harvesting as climate smart agriculture practice combined with agro-advisories effectively therefore significantly post-harvest losses was reduced by uncertain rainfall during harvesting operations. Farmers who adopted mechanical harvesting reported higher yields, reduced post-harvest losses and increased income compared to those who used manual harvesting. Among the respondents, 32.8% and 11.2% farmers reported that advisory on weather forecast communicated during paddy harvesting was useful and somewhat useful respectively. The usefulness of mechanical harvesting as a climate-smart agriculture practice combined with agro-advisory services in paddy harvesting may be influenced by age, education level, and landholding size of farmers. Older farmers may have less experience with mechanical harvesting technology and may be more accustomed to traditional harvesting methods. Farmers with higher levels of education may be more likely to access and understand the information and recommendations provided by agro-advisory services. They may also be better able to implement these practices on their farms. Farmers with larger landholdings may have greater resources and capacity to adopt new agricultural technologies and practices. They may also be more likely to benefit from economies of scale in the implementation of climate-smart agriculture practices.

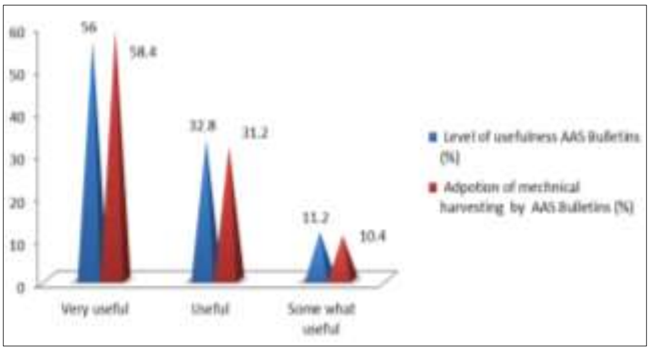

Fig 3: Usefulness and Impact of Agro – Advisory Service

3.5. Constraints in adoption of mechanical harvesting as a climate-smart agriculture practice

There are several constraints that farmers may face in adaptation to climate change which harness the adaptation procedure. Fig. 4 shows that study also identified some challenges facing farmers in adopting mechanical harvesting, including high costs, limited availability of the reaper at village level, high rates on custom hiring basis, lack of appropriate infrastructure etc.

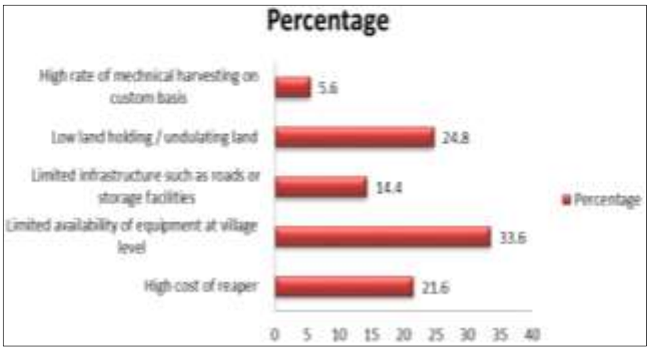

Fig 4: Constraints in adoption of mechanical harvesting as a climate-smart

4. Conclusion

The present study concludes that there is a positive impact of capacity development programmes with dissemination of agro-advisories on farmers' technological knowledge about climate change, mechanical harvesting and its adoption. Mechanical harvesting in combination with Agro advisories can help farmers quickly and efficiently harvest crops before adverse weather conditions can affect them. This can help reduce the risk of post-harvest losses caused by overripe or damaged crops, which may occur if harvesting is delayed due to uncertain rainfall. Therefore, by combining mechanical harvesting with Agro-advisories is a best and effective climate smart agriculture practice for farmers as it can be better equipped to cope with uncertain rainfall conditions and achieve sustainable agricultural production. This would help to improve the livelihood and food security as well as enhance the resilience of agricultural systems to climate change.

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