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Understanding the Knowledge Level of Farmers towards Climate Smart Agricultural Technologies in Agro-climatic Zones of Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Although farmers experience various technical, technological, production, labor-related and marketing constraints to carry out agricultural activities, climate change acts as the root cause of several other constraints. Climate change consequences drastically reduce agricultural yield by

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affecting critical changes of crop growth and questions food and nutritional security; additionally it also imposes economic loss to the country. Hence, to ensure food and nutritional security for the growing population and to ensure sustainable income for the farming community, a farmer has to tackle the consequences of climate change by adoption of CSA technologies Farmer's knowledge level towards any technology, determine its rate of adoption. Hence, this study aims to assess the knowledge level of farmers towards CSA technologies in Agro-climatic zones of Tamil Nadu.

Study design: Ex-post facto research design was employed in the study.

Place and Duration of Study: The study was carried out in seven agro-climatic zones of Tamil Nadu viz., Villupuram district of North Eastern Zone, Namakkal district of North Western Zone, Coimbatore district of Western Zone, Tiruvarur district of Cauvery Delta Zone, Ramanthapuram district of Southern Zone, Kanyakumari district of High Rainfall Zone and the Nilgiris district of the Hilly Zone of Tamil Nadu during 2022-2023.

Methodology: From each of Agro-climatic zones of Tamil Nadu, the vulnerable districts or the districts with NICRA project have been identified and the CSA technologies adopted by the farmers were documented. Thirty farmers who adopts CSA technologies from each agro-climatic zone were selected and interviewed personally to assess their knowledge level towards those technologies in a five point continuum ranging from 'No knowledge' (1), 'Minimal knowledge' (2), 'Basic knowledge' (3), 'Adequate knowledge' (4) and 'Superior knowledge' (5) respectively. The gathered responses were subjected to percentage analysis.

Findings: The findings revealed that Villupuram, Coimbatore and Tiruvarur farmers had superior knowledge on precision based nutrient management, Namakkal farmers had superior knowledge on use of additives and supplements in livestock feed, Ramanathapuram farmers had superior knowledge on utilization of weather based agro-advisory services, Kanyakumari farmers had superior knowledge on adoption of moisture conservation practices and Nilgiris farmers had superior knowledge on adoption of improved seed varieties and use of biofertilizers.

Conclusion: Villupuram, Coimbatore and Tiruvarur farmers had superior knowledge on precision based nutrient management; Namakkal farmers had superior knowledge on use of additives and supplements in livestock feed; Ramanathapuram farmers had superior knowledge on utilization of weather based agro-advisory services; Kanyakumari farmers had superior knowledge on adoption of moisture conservation practices and, The Nilgiris farmers had superior knowledge on adoption of improved seed varieties and use of biofertilizers. Thus, it can be concluded that farmers had superior knowledge on CSA technologies based on their perceived climatic change consequences and their accessibility to location specific technologies.

Keywords: CSA technologies; climate smart agriculture; agro-climatic zones; Tamil Nadu; knowledge level; climate change.

1. INTRODUCTION

Climate change is the change in weather conditions due to natural and man-made causes for a prolonged period which alters the global composition and results in negative consequences such as severe drought, delayed rainfall, increased intensity of rainfall, unpredictable rainfall, flood and so on. Climate change declines the production and reproduction efficiency of livestock [1]; causes respiratory tract infection in children and asthma in adults [2]; affects spatial distribution of agro-ecological zones [3] and so on. Though several sectors are invariably affected by consequences of climate change, agriculture is the severely affected sector as it highly depends on natural resources like soil, water and air.

Several studies reported that climatic change consequences such as increase in temperature reduce wheat production [4], affects the fiscal policies of highland range [5], increase autotrophic CO_2 losses from soil as a result of increased soil temperature [6] and dry season below temperature damages crop growth [7]. Among the several climatic change consequences, increasing temperature and declining rainfall are the significant negative impact of climate change that threatens agricultural production and food security [8]. Saravanakumar [9] pointed out that climate change is expected to reduce rice yields by 283 kg per ha per decade and sorghum yields by 88 kg per ha per decade by 2100, representing a 10% and 9% fall in yields by the end of the 21st century, respectively, compared to average yields from 1971 to 2009**.**

While, IFPRI (International Food Policy Research Institute) in their Global Food Policy report mentioned that climate change will push 90 million towards hunger. Several studies revealed that majority of the farmers had knowledge about climate change [10,11]; whereas, two-fifth of the paddy growers in Mandya had medium level of knowledge on climate resilient technologies [12] and nearly three-fifth of the farmers in Ananthapuram district of Andhra Pradesh had medium level of knowledge on climate resilient technologies due to the impact of NICRA project [13].

1.1 Statement of the Problem

Apart from ensuring food security to the World population, agriculture provides employment opportunity large number of Indian population. Among the Indian farmers, approximately 82 per cent of them are small farmers and they have to encounter several production, technical, technological and marketing related constraints in agriculture. Additionally, the consequences of climate change pose additional threats such as increasing the incidence of pests and diseases, deterioration in soil fertility, promote salinity, defiance many pesticides and herbicides and deterioration of quality of irrigation water [14]. Hence, to tackle the aforementioned constraints, the farmers has to adopt Climate Smart Agriculture (CSA) technologies which improve productivity, improve resilience and reduce emission of greenhouse gas. Whereas, to adopt the CSA technologies, it become necessary that the farmer should had prior knowledge about the available CSA technologies. In this context, the present study aims to assess the knowledge level of the farmers towards CSA technologies in agro-climatic zones of Tamil Nadu.

2. METHODOLOGY

To achieve this objective, the present study was conducted in seven different agro-climatic zones of Tamil Nadu. Villupuram district of North Eastern Zone, Namakkal district of North Western Zone, Coimbatore district of Western Zone, Tiruvarur district of Cauvery Delta Zone, Ramanthapuram district of Southern Zone, Kanyakumari district of High Rainfall Zone and the Nilgiris district of the Hilly Zone were selected to understand the knowledge level of farmers towards CSA technologies. From each agro-climatic zone, the adopted CSA technologies were documented by employing Focus Group Discussion & CSA rural appraisal techniques. Later, the documented CSA technologies from all the agro-climatic zones of Tamil Nadu were compiled and the knowledge level of the farmers towards CSA technologies in Agro-Climatic Zones of Tamil Nadu is assessed. Knowledge level of a farmer can be operationalized as their level of understanding of information, facts and skills towards the CSA technologies. It was assessed against the fivepoint continuum, ranging from ‘No knowledge’ (1), ‘Minimal knowledge’ (2), ‘Basic knowledge’ (3), ‘Adequate knowledge’ (4) and ‘Superior knowledge’ (5) based on the Problem Rating Scale for Outcomes (2005). The measures of five-point continuum can be described as follows;

- **No knowledge:** No technical knowledge (know-how) about the CSA technology
- **Minimal knowledge:** Knows the existence of the technology but lacks technical knowledge about the CSA technology
- **Basic knowledge:** Knows the existence and importance of the technology but lacks technical knowledge about the CSA technology
- **Adequate knowledge:** Had technical knowledge and skills about the CSA technology for a good performance
- **Superior knowledge:** Had knowledge about the principles underlying in the functioning of CSA technologies or practices. It would be higher than other farmers or the knowledge level equal to an extension agent gained about the CSA technology out of personal interest.

The gathered responses are subjected to percentage analysis for making comparisons between the continuum and the findings are presented in the subsequent sections.

3. RESULTS AND DISCUSSION

The Technology wise knowledge level of Villupuram farmers towards CSA technologies is presented in Fig. 1.

Regarding the technology-wise knowledge level of Villupuram farmers (Fig 1.), it can be understood that higher percentage of the farmers had basic knowledge on crop insurance (70.00%), improved seed varieties (56.67%), use of biofertilizers and slow releasing nitrogenous fertilizers (56.67%), use of improved agricultural implements (56.67%) and crop diversification (50.00%). This is due to the fact, that conducting

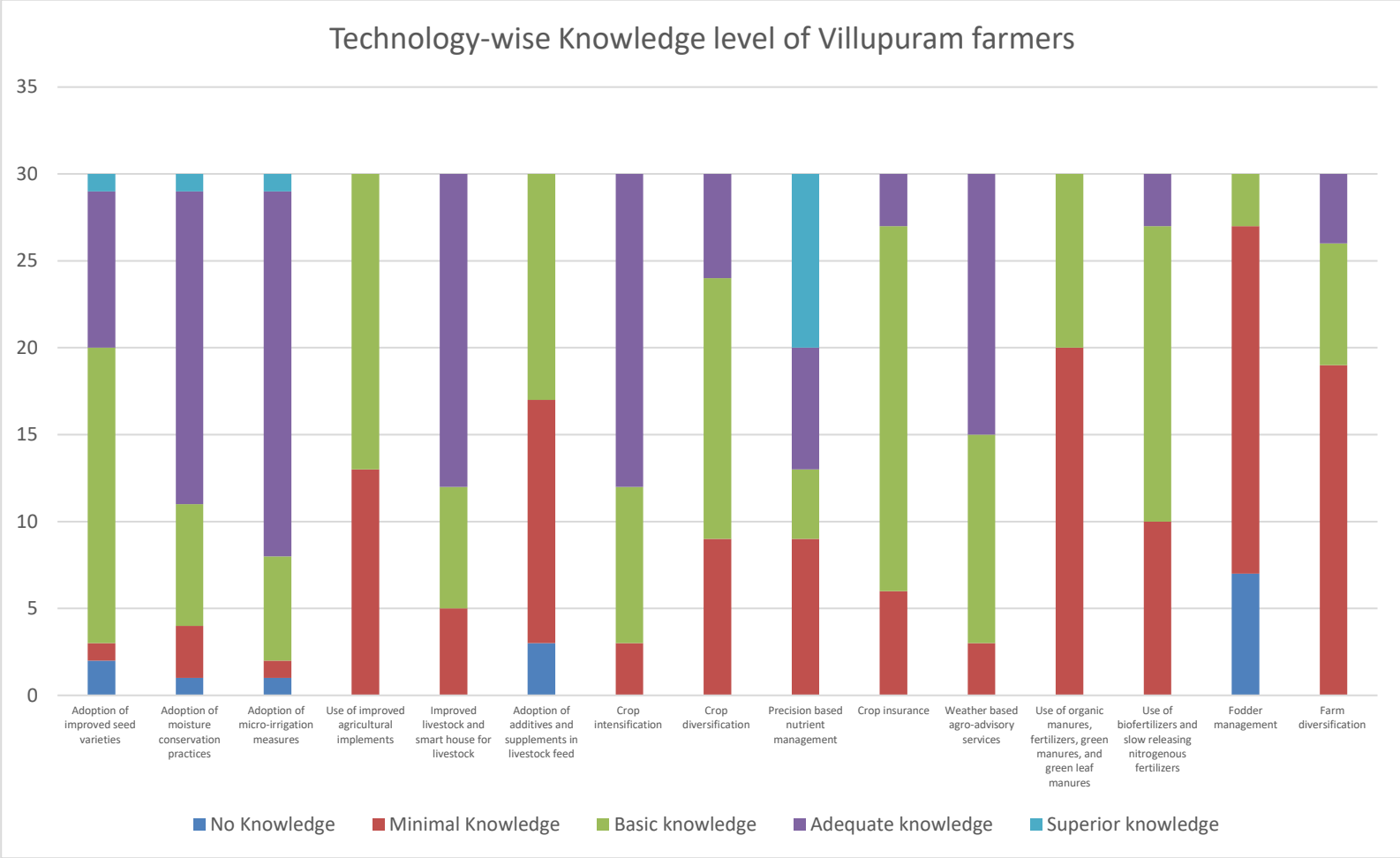

Fig. 1. Distribution of Villupuram farmers based on their knowledge level towards CSA technologies

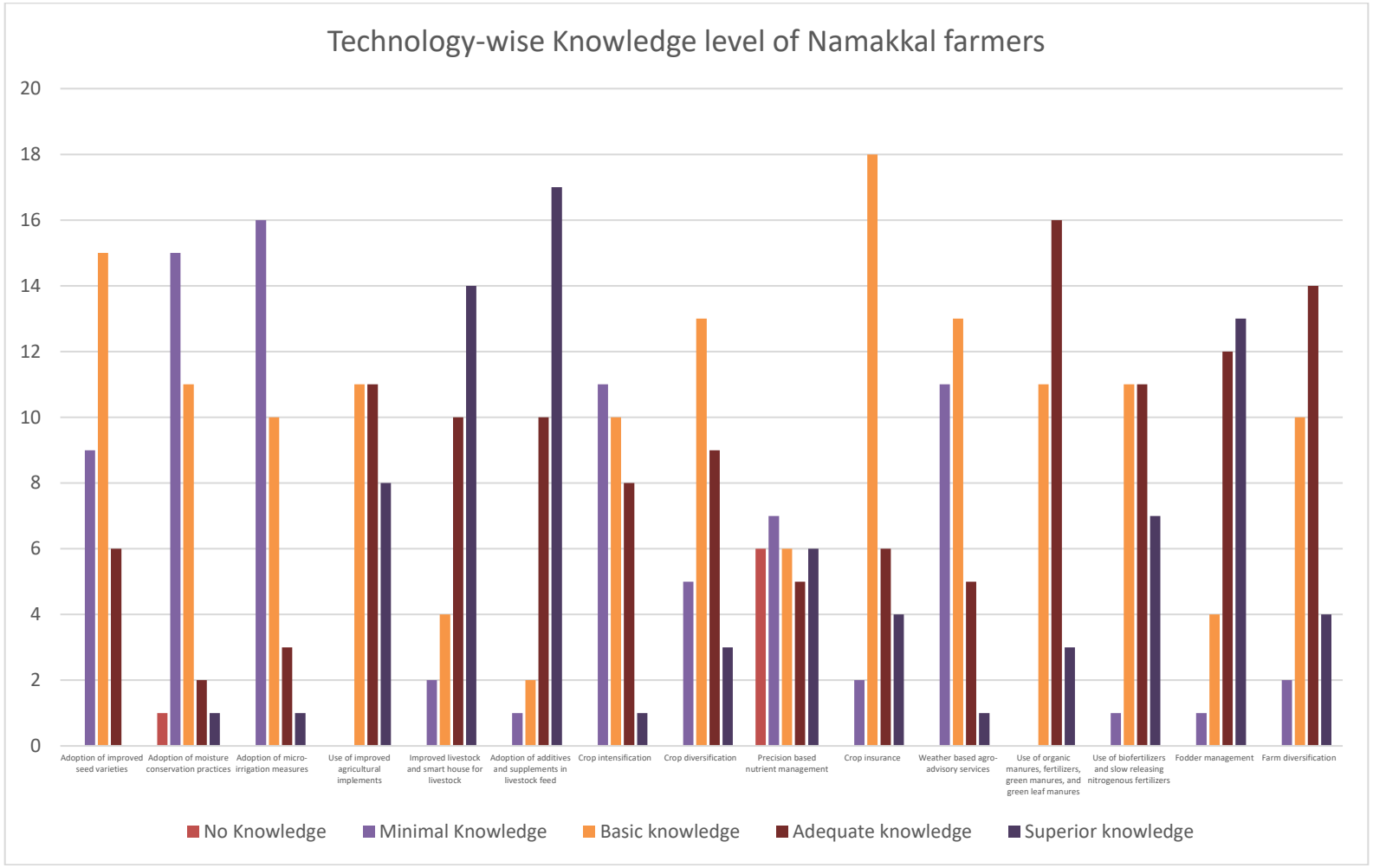

Fig. 2. Distribution of Namakkal farmers based on their knowledge level towards CSA technologies

demonstrations on biofertilizer usage by the extension officers, provide awareness among the farmers about the existence of the technology and provide basic knowledge to the farmers. Further, the need of crop insurance to gain insurance amount when crop loss occurs due to climatic change, need of improved agricultural implements and improved seed varieties to mitigate climate change enable them to cater their needs by seeking information from various sources, which resulted in basic knowledge level of the farmers. Meanwhile, most of the farmers had adequate knowledge on adoption of micro-irrigation measures (70.00%) and moisture conservation practices (60%), adoption of improved livestock breeds and use of smart house for livestock (60.00%), crop intensification (60.00%) and utilization of weather based agro-advisory services (50.00%). As Villupuram farmers experience severe drought, they were in need of moisture conservation measures like construction of farm pond, mulching and micro-irrigation measures like rainhose and drip irrigation; hence, the KVK and the farmer's out of their own interest adequate knowledge. Simultaneously, to provide additional income Villupuram farmers rear livestock which is also affected by climate change. As a result, to protect livestock from climate change, the farmers had adequate knowledge on improved livestock breeds and use of smart house for livestock. Meanwhile to mitigate climate change experienced by Villupuram farmers, they have to use weather based agro-advisory services and crop intensification measures like intercropping with legumes and crop rotation which provides adequate knowledge on CSA practices. Whereas, higher percentage of the farmers had minimal knowledge on fodder management (66.67%), use of organic manures, fertilizers, green manures and green leaf manures (66.67%), diversification of farm (63.33%) and use of additives and supplements in livestock feed (46.67%). Eventually, 33.33 per cent of the farmers had superior knowledge on precision based nutrient management. Since the benefits of organic manures and fertilizers are perceived late, they had minimal knowledge on use of organic manures and fertilizers, green manures and green leaf manures. Though farmers rear livestock they had minimal knowledge on additives and supplements because of the high price and unavailability of the products. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Namakkal farmers towards CSA technologies is presented in Fig. 2.

With respect to technology wise knowledge level of Namakkal farmers, it was revealed that farmers had basic knowledge in utilization of crop insurance (60.00%), adoption of improved seed varieties (50.00%), crop diversification (43.33%) and utilization of weather based agro-advisory services (43.33%). This could be due to the fact, farmers in the study area cultivate onion because of the water availability and climatic conditions, but it often lead to loss due to climate change. Hence, the farmers had basic knowledge on utilization of crop insurance to recover from loss, adoption of improved seed varieties and utilization of weather based agro-advisory services to mitigate climate change and crop diversification to ensure assured income incase of crop failure. Further, famers had minimal knowledge on adoption of micro-irrigation measures (53.33%), adoption of moisture conservation practices (50.00%) and crop intensification (36.67%) as the farmers were aware of the technology but lacks technical knowledge on Water Use Efficiency; whereas, most of the farmers had adequate knowledge on use of organic manures, fertilizers, green manures and green leaf manures (53.33%) since the farmers cultivate green manures and incorporate into field for increased yield of onion. Similarly, higher percentage of the farmers had superior knowledge on adoption of additives and supplements in livestock feed (56.67%), use of improved livestock breed and smart house for livestock (46.67%), fodder management (43.33%), use of improved agricultural implements (26.66%), use of biofertilizers and slow releasing nitrogenous fertilizers (23.33%) and precision based nutrient management (20.00%). This could be because of, apart from agriculture rearing of livestock is the occupation for majority of the respondents, which increased their knowledge on use of improved livestock breed and smart house for livestock, fodder management, and use of livestock additives and supplements for the livestock. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Coimbatore farmers towards CSA technologies is presented in Fig. 3.

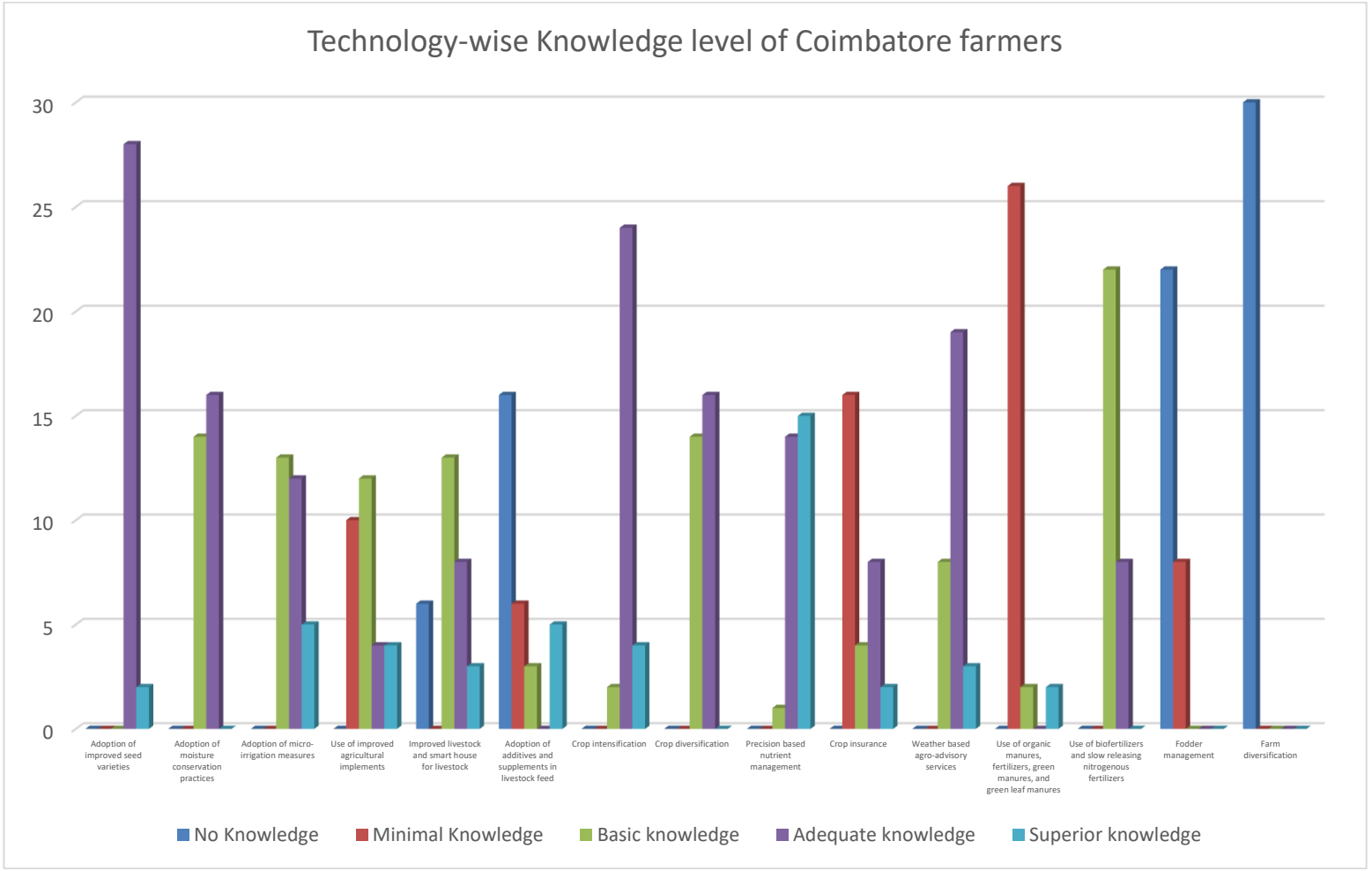

Fig. 3. Distribution of Villupuram farmers based on their knowledge level towards CSA technologies

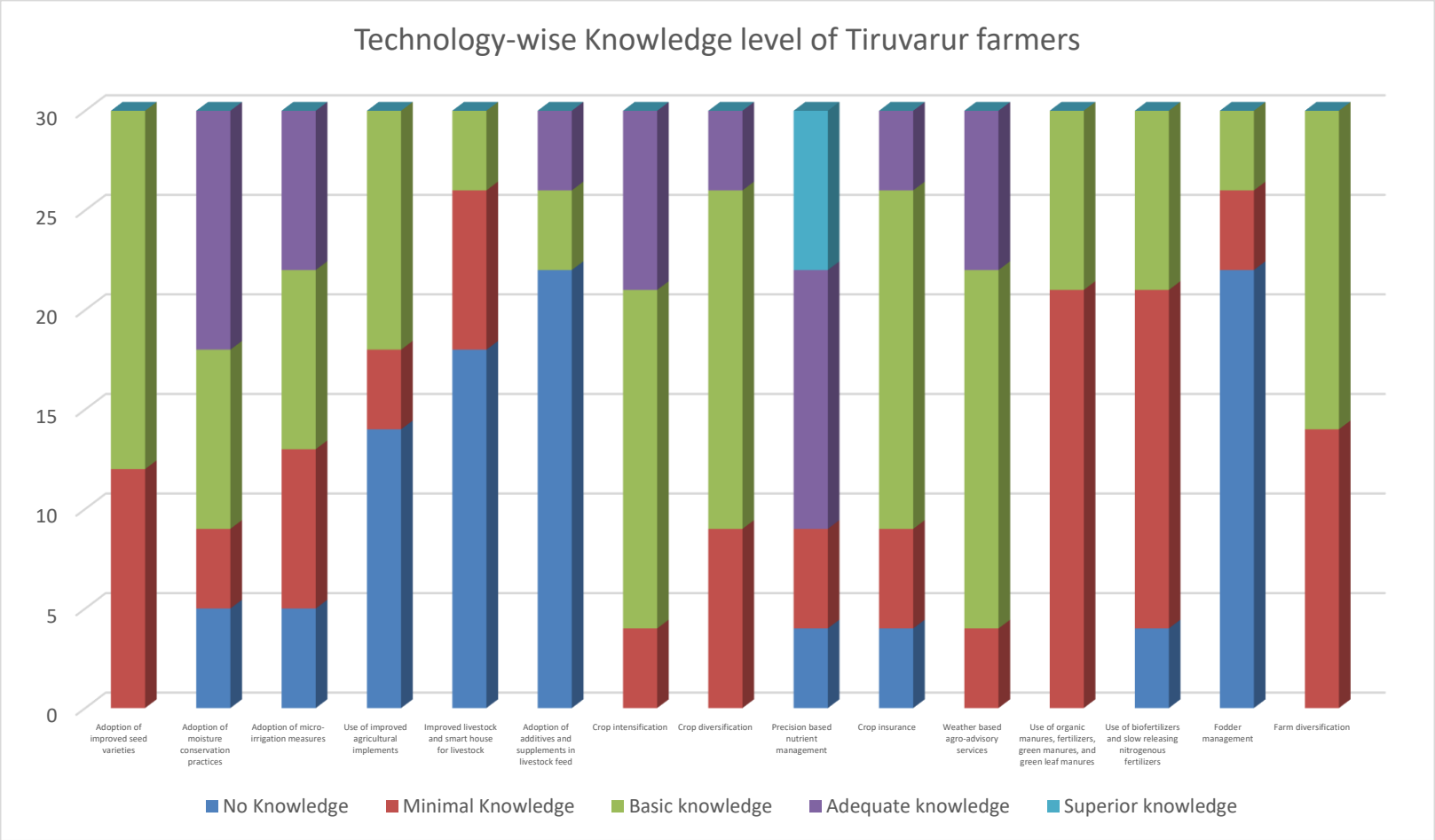

Fig. 4. Distribution of Tiruvarur farmers based on their knowledge level towards CSA technologies

The knowledge level of Coimbatore farmers towards CSA technologies (Fig. 3) revealed that, majority of the farmers had adequate knowledge on adoption of improved seed varieties (93.33%), crop intensification (80.00%), weather based agro-advisory services (63.33%), crop diversification (53.33%) and adoption of moisture conservation practices (53.33%) as they have to mitigate climate change by using weather based agro-advisory services, adoption of improved seed varieties and adoption of moisture conservation practices like construction of farm pond to save runoff water. Meanwhile, most of the farmers had basic knowledge on use of biofertilizers and slow releasing nitrogenous fertilizers (73.33%), adoption of micro-irrigation measures (43.33%), adoption of improved livestock breed and use of smart house for livestock (43.33%) and use of improved agricultural implements (40.00%). It could be because of the fact that, rearing of livestock and use of agricultural implements to carry out agricultural activities are indispensable part of famer's life, hence they had basic knowledge towards those technologies. Whereas, farmers had no knowledge in diversification of farm (100%), fodder management (73.33%) and adoption of additives and supplements in livestock feed (53.33%). In the meantime, farmers had minimal knowledge on use of organic manures, organic fertilizers, green manures and green leaf manures (86.66%), crop insurance (53.33%). This could be because of the higher price of livestock additives, utilizing agricultural land only for cultivation of food crops and not for fodder crops and the benefits of using organic manures and fertilizers are perceived late.Coimbatore farmers had superior knowledge on precision based nutrient management (50.00%) as they were aware of importance fertilizers application based on soil analysis. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Tiruvarur farmers towards CSA technologies is presented in Fig. 4.

Considering the technology wise knowledge level of Tiruvarur farmers (Fig. 4), it was found that exactly three-fifth of the farmers had basic knowledge on adoption of improved seed varieties (60.00%), weather based agro-advisory services (60.00%), crop intensification (56.67%), crop diversification (56.67%), crop insurance (56.67%) and diversification of farm (53.33%). This could be because of farmers awareness about the importance of crop intensification and crop diversification practices in mitigating climate change and ensuring assured income. Meanwhile, most of the farmers had adequate knowledge on precision based nutrient management (43.33%) and adoption of moisture conservation practices (40.00%); basic knowledge on adoption of micro-irrigation measures (30.00%) due to accessibility to the soil testing centers, trainings attended by the farmers, awareness campaigns conducted by the State Department of Agriculture and the demonstrations conducted by the extension officers. Farmers had minimal knowledge on use of organic manures, organic fertilizers, green manures and green leaf manures (70.00%) and use of biofertilizers and slow releasing nitrogenous fertilizers (56.67%) as the benefits of organic manures and fertilizers are perceived late and increased pest and disease attack due to climate change. Eventually, higher percentage of the farmers had no knowledge on use of additives and supplements in livestock feeds (73.33%), fodder management (73.33%), adoption of improved livestock breeds and use of smart house for livestock (60.00%) and use of improved agricultural implements (46.67%). It is due to the lack of farmer's interest to try livestock additives and smart house for livestock because of higher price. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Ramanathapuram farmers towards CSA technologies is presented in Fig. 5.

With respect to the technology wise knowledge level of Ramanathapuram farmers (Fig. 5), most of the farmers had adequate knowledge on adoption of micro-irrigation measures (100%) and moisture conservation practices (80.00%), precision based nutrient management (80.00%), adoption of improved seed varieties (60.00%), crop intensification (60.00%), diversification of farm (60.00%) and weather based agro-advisory services (40.00%). This could be because of the frequent trainings and demonstrations conducted by extension officers and awareness campaigns of State and Central Government. Meanwhile, Ramanathapuram farmers had basic knowledge on crop insurance (80.00%), use of improved agricultural implements (60.00%), adoption of additives and supplements in livestock feed (60.00%), crop diversification (40.00%), use of organic manures, organic fertilizers, green manures and green leaf manures (40.00%), use of biofertilizers and slow releasing nitrogenous fertilizers (40.00%). Ramanathapuram farmers

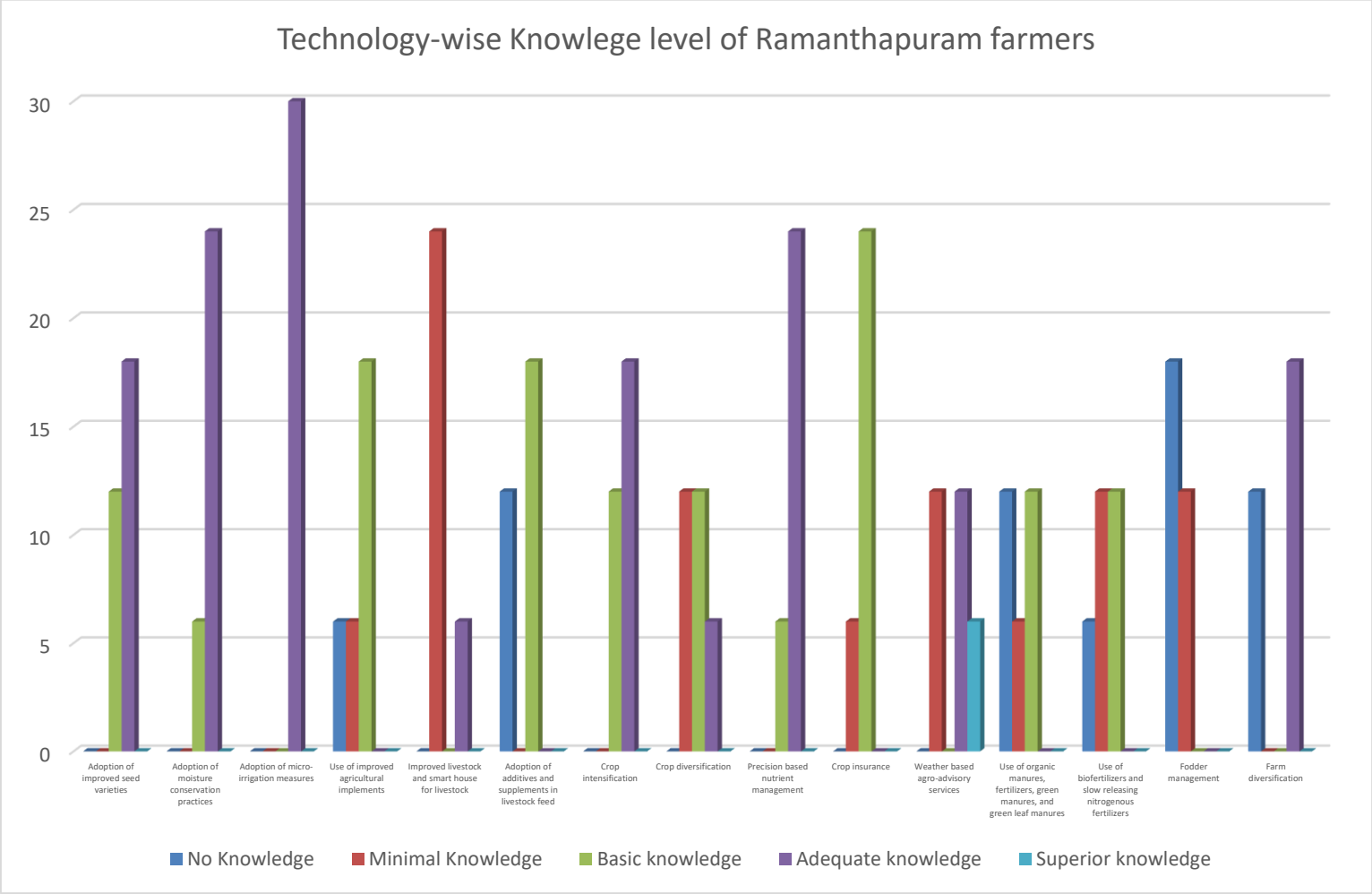

Fig. 5. Distribution of Ramanathapuram farmers based on their knowledge level towards CSA technologies

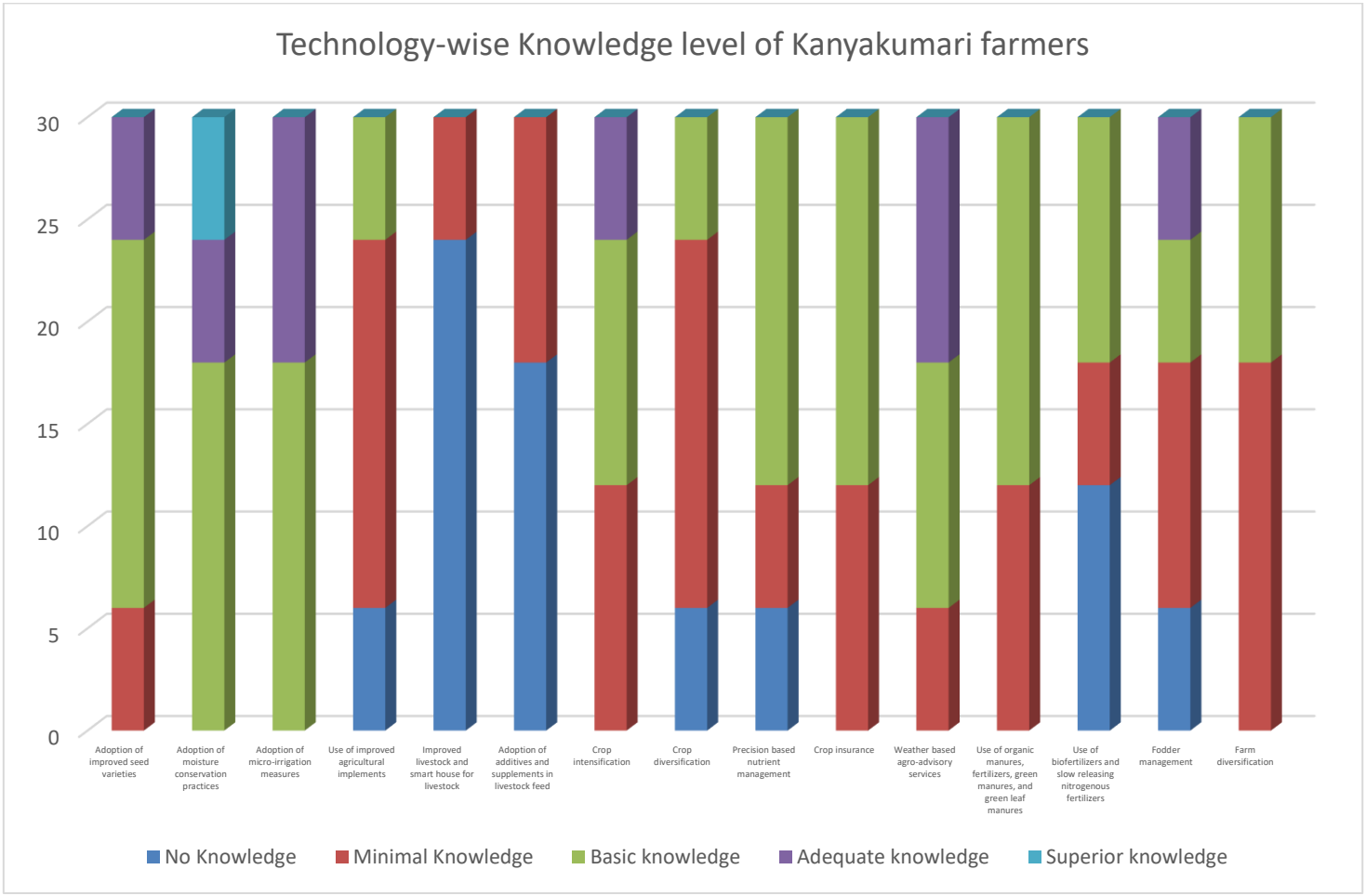

Fig. 6. Distribution of Kanyakumari farmers based on their knowledge level towards CSA technologies

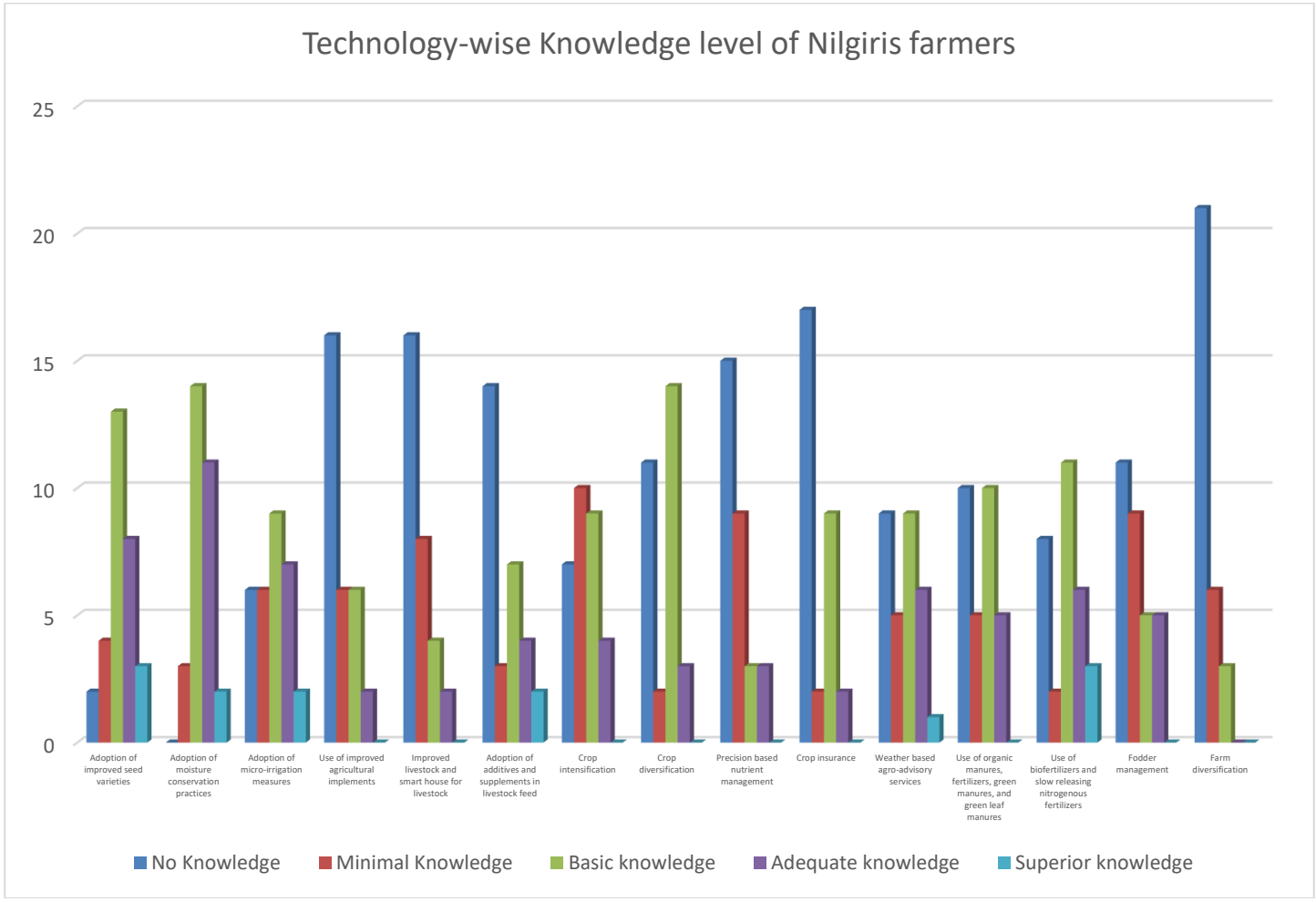

Fig. 7. Distribution of Nilgiris farmers based on their knowledge level towards CSA technologies

had superior knowledge on utilization of weather based agro-advisory services, as the district experiences high temperature and optimum irrigation water, onset of rain helps the farmers to mitigate water stress. Sometimes, early and delayed onset of rainfall during harvesting and sowing reduce the crop yield. Hence, farmers utilize Kisan Call Centre, mobile apps and news in TV and radio to know the weather forecast to carry out agricultural activities. Eventually, it is observed that farmers had minimal knowledge on adoption of improved livestock breed and use of smart house for livestock (80.00%) and no knowledge on fodder management (60.00%). Though the farmers rear livestock, they are not aware of the use of smart house for livestock because of lack of exposure. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Kanyakumari farmers towards CSA technologies is presented in Fig. 6.

Considering the technology-wise knowledge level of Kanyakumari farmers (Fig. 6), it can be understood that higher percentage of farmers had basic knowledge on adoption of improved seed varieties (60.00%), adoption of moisture conservation practices (60.00%), precision based nutrient management (60.00%), crop insurance (60.00%), adoption of micro-irrigation measures (60.00%), use of organic manures, organic fertilizers, green manures and green leaf manures (60.00%), crop intensification (40.00%) and use of biofertilizers and slow releasing nitrogenous fertilizers (40.00%). This could be attributed to the fact that, as the farmers live near to the catchment area, they had basic knowledge on moisture conservation and micro-irrigation measures. Meanwhile, most of the farmers had adequate knowledge on weather based agro-advisory services (40.00%) as unpredictable and high intensity rainfall affects the sowing and harvesting of crops; minimal knowledge on use of improved agricultural implements (60.00%), diversification of farm (60.00%), crop diversification (60.00%) and fodder management (40.00%) as they cultivate rice because of the increased availability of water. Eventually, some of the farmers had no knowledge on adoption of improved livestock breeds and use of smart house for livestock (80.00%) and adoption of additives and supplements in livestock feed (60.00%); because of their lack of exposure to improved livestock breeds and smart house for livestock, additives and supplements in the livestock feed. Additionally, Kanyakumari farmers had superior knowledge on adoption of moisture conservation practices as opening of dams is not planned and couldn't had any water conservation measures like check dam, reduced water conservation. To fuel it up, consequences of climate change such as delayed onset of rainfall and increased rainfall intensity at critical stages of crop growth reduced crop yield. Hence, the farmers had superior knowledge on several moisture conservation measures to conserve water. The findings are line with the studies of Manjunath [12] and Kalyan [13].

The Technology wise knowledge level of Nilgiris farmers towards CSA technologies is presented in Fig. 7.

Regarding the technology wise knowledge level of Nilgiris farmers (Fig. 7), most of the farmers had basic knowledge on adoption of moisture conservation practices (46.67%), crop diversification (46.67%), adoption of improved seed varieties (43.33%), use of biofertilizers and slow releasing nitrogenous fertilizers (36.67%), use of organic manures, organic fertilizers, green manures and green leaf manures (33.33%), adoption of micro-irrigation measures (30.00%), crop intensification (30.00%) and weather based agro-advisory services (30.00%). Meanwhile, most of the farmers had no knowledge on farm diversification (70.00%), crop insurance (56.67%), precision based nutrient management (50.00%), use of improved agricultural implements (53.33%), adoption of improved livestock breed and use of smart house for livestock (53.33%), adoption of additives and supplements in livestock feed (46.67%) and fodder management (36.67%).Eventually, Nilgiris farmers had superior knowledge on adoption of improved seed varieties and use of biofertilizers as they had to adopt improved seed varieties which are resistant to frost, pest and disease resistant, water logging resistant to encounter increased pest and disease attack, severe frost damage, unpredictable and increased rainfall intensity. By understanding the knowledge level of the farmers towards CSA technologies, interventions and policies can be formulated to increase the adoption of CSA technologies and to reduce the impact of climate change on agriculture and other allied sectors thereby improving the livelihood of the farmers. The findings are line with the studies of Manjunath [12] and Kalyan [13].

4. CONCLUSION

Being an agricultural economy and to ensure food and nutritional security for the growing Indian population, farmers has to tackle the consequences of climate change. As the farmers have to combat with climate change, in addition to several other production, technical and marketing constraints, provision of timely weather based agro-advisory services enable them to reduce yield losses. Thus, it can be concluded that, farmers had superior knowledge on CSA technologies based on their perceived climatic change consequences and their accessibility to location specific technologies. Further, it was suggested that, farmers should be made aware of other CSA technologies by conducting awareness campaigns, establishing demonstration units and outreach centers as it helps to improve resilience.

CONSENT

All authors declare that 'research was conducted with ethical considerations and respondents were interviewed after obtaining written consent for publication of the results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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