FARMER INNOVATIONS IN THE FIELD OF AGRICULTURAL MACHINERY: A MULTI-DIMENSIONAL ANALYSIS

By

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(2020-11-075)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE IN AGRICULTURE

(AGRICULTURAL EXTENSION EDUCATION)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

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DECLARATION

I, Jaizen Kuriakose (2020-11-075) hereby declare that this thesis entitled **"Farmer innovations in the field of agricultural machinery: A multi-dimensional analysis"** is a bonafide record of research work done by me during the course of research and the thesis has not been previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other university or society.

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ACKNOWLEDGEMENT

First and foremost, I am thankful to ***Almighty GOD*** *for giving me the strength, knowledge, ability, and opportunity to undertake this research study and to persevere and complete it satisfactorily. Without his blessings, this achievement would not have been possible.*

It is a genuine pleasure to express my deep sense of thanks and gratitude to my major advisor ***Dr. Sunil V. G.,*** *Assistant Professor and Head, Communication Centre, for his worthy guidance and professional attitude. His dedication and keen interest above all his overwhelming attitude to help students had been solely and mainly responsible for completing my work. His timely suggestions, meticulous scrutiny, scholarly advice, and scientific approach have aided me to a very great extent to accomplish this research.*

Besides my advisor, I owe a deep sense of gratitude to ***Dr. Binoo P. Bonny, Dr. Jayasree Krishnankutty M.*** *and* ***Mr. Ayyoob K. C.*** *for their solid encouragement, timely support, expert advice, valuable suggestions and critical evaluation of the manuscript that has helped me for the improvement and preparation of the thesis throughout the course of my research.*

I owe my deepest gratitude to ***Dr. Mercikutty M. J., Dr. Smitha Baby, Dr. Smitha S., Dr. Sulaja O. R.*** *and* ***Dr. Allan Thomas T.*** *for their ever-willing help, valuable guidance and creative suggestions throughout the period of my study.*

I sincerely thank ***Jaliya M. K.*** *and* ***Dr. Chinchu V. S.*** *for their help, valuable suggestions and immense support throughout the period of my study. I am extremely thankful to all the faculties and staffs of Communication Centre, Mannuthy and Agribusiness Incubation Centre, Vellanikkara for their immense cooperation and support during the period of my study. I convey my extreme gratitude to all the respondent farmer innovators, facilitators, progressive farmers and research scientists for having helped me during my data collection.*

I am extremely grateful to my beloved senior ***Swathy Suresh K. S.*** *for critical evaluation during my analysis and research works. It gives me great delight in acknowledging her for the wholehearted help, unconditional support and strength throughout the entire course of my study. I express my heartfelt gratitude to dearest seniors especially* ***Akhil Ajith, Vivek S.*** *and* ***Parvathy Sasidharan*** *for being with me, a call away during the entire course of my study.*

I appreciate all my seniors ***Rose Mathews, Greeshma Susan, Cibin J Das, Bhavana Sajeev, Salpriya and Ahaljith*** *for their guidance and unconditional support. A special note of thanks to my batch mates* ***Sreejith, Atheena, Swapna*** *and* ***Reshma*** *who helped me in one way or the other way throughout the period of my study. I am thankful to my juniors especially* ***Manoj, Joel*** *and* ***Navitha*** *for their immense support throughout.*

I am extremely thankful to ***Mr. Ashish Benny, Ms. Jintu, Ms. Shafreena. and Mr. Sooraj*** *for their support .I am thankful to remember the services rendered by all the staff members of Student's computer club, College Library, Office of COA and Academic cell ,Kerala Agricultural University. I thankfully remember the services rendered by all the staff members of the* ***Student's computer club, Library, College office****, and* ***Central library, KAU****. I am also thankful to* ***Kerala Agricultural University*** *for technical and financial assistance for carrying out my study and research work.*

I have no words to express the quantum of love and gratitude to all my dearest friends and seniors especially ***Basil Chackochan, Vaishnav, Anupama, Midhuna, Ribin, Mridul, Manoj, Adish Raj, Adarsh, Thabsheer, Abhijith, Aida, Geethika, Amruthalakshmi, Junaidath, Athira Sebastian, Mintu, Arya, Sreelakshmi, Abhina Krishna , Jaseena, Josmi John, Siril P. S., Nikhil K. S., Sreekanth M. S., Athul, Omji,*** *and all my batchmates of PG 2020 batch for all the support and encouragement that I received during the entire period of my study.*

I am deeply grateful to my entire family for their support, appreciation, encouragement, and a keen interest in my academic achievement. Words cannot really express the love, care, and boundless support that I relished from my beloved parents ***Mr. Kuriakose K. P*** *and* ***Mrs. Jolly Jacob****, my brother Mr.* ***Jinzen Kuriakose*** *and my uncle* ***Mr. Joby Jacob.*** *I am affectionately dedicating this thesis to them for their selfless sacrifice.*

A word of wholehearted apology to those whom I have not mentioned in person and a note of thanks to everyone who helped me for the successful completion of this endeavor.

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Jaizen Kuriakose

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Introduction

CHAPTER 1

INTRODUCTION

In India, agriculture is the primary income source for the vast majority of people and should never be overlooked. Even while agriculture's share of the GDP has dropped to under 20% and other sectors' contributions have accelerated, agricultural production has climbed nonetheless. As a result, we are now a net exporter of agriculture and related goods instead of being a food-begging bowl after gaining independence. Agriculture has long been a focal point in the global development conversation. A large portion of the rural population in emerging nations depends entirely or partly on agriculture; hence the industry is crucial for growth. However, agriculture has many problems, from local infrastructure to international trade.

Innovations are essential to agriculture since they set the stage for the industry's expansion and improvement. Small and large agricultural innovations have acted as catalysts for more extensive changes, including the tying of people to the land, land ownership, population growth, specialisation, social hierarchy, acquisition of wealth and prestige, colonisation of agriculturally marginal land, increases in production, trade and exchange, urbanization, and ultimately the rise of the state and the development of our own modern world.

The phrases 'technology' and 'innovation' are sometimes used interchangeably, yet they might be defined differently. Innovations have been intrinsic in Indian agriculture from time immemorial, and Indian farmers are no exception. Multi-stakeholder partnerships and innovations are the pathways for future agricultural extension and advisory services to reach needy farmers and others (Saravanan and Suchiradipta, 2017).

The concept of innovation

The concept of innovation dates back to its definition by Rogers as ‘an idea, practice or object that is perceived as new by an individual or other unit of adoption’ (Rogers, 1962). Later on, Gibbons *et al.* (1994) noted that innovation is an uncertain

concept that requires the blurring of boundaries in the production of scientific knowledge. Innovation Systems are currently thought of as a result of the theory of innovation, which include new crops and plants, animal breeds, chemicals and medications, new methods of doing things, and other technologies and practices generated via study. When a person first becomes aware of a concept or practice, regardless of when it was formed, it is an innovation to himself. Innovation is using something old in new ways or something new to successfully create desired social and economic outcomes.

Dasgupta (1989) mentioned that innovation is an idea, object, or practice perceived as new or an improvement over the existing one by the members of a social system. An innovation may be divided into two parts: the 'concept,' which is the fundamental element of the innovation, and the 'material' form,' which is the second portion of it. On the other hand, technology is a design for instrumental action that decreases ambiguity in the cause-effect connection involved in reaching the desired result. This concept suggests a need or problem that a 'tool' can assist in addressing. The tool has two parts: (1) hardware (material, equipment, goods, and so on) and (2) software (knowledge, skills, methods, and concepts that serve as the tool's information base) (Rogers, 1995).

The innovation does not have to be new to the world or science but just to the context in which it is applied. Key questions in the innovation process are, of course, why and when innovations occur and by whom they are initiated. The need for change, the desire for change, and the flash of genius are all components of this debate. While external factors, such as population growth and environmental change, will undoubtedly, play a role in some instances, the incentive for change is likely to have been a more vital ingredient.

Importance of farmer innovations

Farmer innovators are people who frequently seek to tackle localized problems and operate outside of official institutions. To increase their living standard, Indian farmers continually strove to make farming more efficient and cost-effective, and these

innovations helped improve farming techniques over time, ensuring improved living possibilities.

According to Roling (2009), farmers have been innovating long before the beginning of formal research by scientists for development. Several studies have shown that some of the technologies produced by scientists were really based on local farmers' ideas. Innovations are critical in food production and farmers' efficient use of resources. When a person first becomes aware of a concept or practice that was initially conceived, regardless of the time, it is an innovation to that individual. This information may be entirely new, but it may also entail the reapplication of previously acquired knowledge of product and process innovations. The amount and intensity with which farmers make decisions is the innovation that eventually produces a difference.

Most farmer-led innovations are labour-saving, lowering production costs and freeing labour from off-farm work. It is believed that farmer innovation development techniques may also have an influence on impoverished people's lives and may constitute the basis for food security (Letty *et al*., 2021). The innovations vary from trying out new ideas to changing or adding value to current or external techniques, all the way to the total discovery of superior agricultural practices. The interaction of ideas from many sources may also result in the formation of new concepts. They might emerge as a result of serendipity, rigorous experimentation, trial and error, or creatively integrating solutions. An accident can sometimes lead to a new discovery. They can also originate from intuition, dreams, work experience, training, suggestions from friends, observations from other places, trouble or poverty, and no way out.

Farmer innovations have the potential to significantly improve the quality of life of farming families while also reducing their environmental impact by developing novel ways to boost productivity, improve organization, or minimize reliance on external inputs. Science may have much to offer resource-poor farmers. Still, the potential of local knowledge and farmer creativity will serve as its foundation as a technical intervention supported by new institutional forms and connections that challenge 'business as usual.'

Innovations in agricultural machinery

Despite the fact that agricultural innovations are being deployed all over the world, their dissemination is typically limited, delayed, and neither communities nor scientists frequently acknowledge them. This might be because there isn't enough documentation to scale up these farmer innovations, or because there aren't enough adaptive trials before commercialization, etc. Choosing the right innovations could boost market food supply and farm output.

However, there is a lack of study that addresses issues like what attributes of innovations caused them to emerge from societies where farming is the primary source of revenue, what were the difficulties that the innovators encountered while developing this innovation..etc.

Objectives of the study

- Documentation of farmer innovations in the field of agricultural machinery
- Evaluation of the attributes of a few selected farmer innovations
- Identification of the constraints faced by the farmer during the phase of development of the innovations

Scope of the study

Researchers and extensionists working in the same field are not often aware of or taking into account about the various attributes of such innovations and re-inventions. Both of these are often unknown to other farmers struggling with the same difficulties.

A study of farmer innovation in this context will be significantly relevant in documenting various farmer innovations. The study outcome implies great significance in analyzing the attributes of the innovations and their current stage of development. Besides, by undertaking a study, we will also be able to determine the constraints in developing the innovation. Thus, it will help a long way to build farmer innovations and make them applicable to the agricultural sector.

The study also has practical utility for planners, policymakers, administrators, extension functionaries, and other agencies by making them aware of various

dimensions and status of farmer innovations in agricultural machinery. Thereby they can plan and execute the appropriate programme for farmer innovations effectively.

Limitations of the study

A genuine effort was made to gather information for this research that was both academically and practically relevant. However, the inherent restrictions of being a single research project apply to this study. Some of the other usual limitations are given below:

1. The information was gathered from a very small percentage of innovative farmers representing many farmer innovations; therefore, the findings may not be generalized.

2. The results are based on the expressed responses of the respondents; therefore, the objectivity of the study depends upon the respondents' free and frank opinions. As a result, it is impossible to rule out that they may have biases or preconceptions while responding.

3. The study was restricted to innovations from the field of agricultural machinery only, and results may not be explainable to other sectors.

4. The study generally suffers from the usual constraints of time, money and other resources encountered by the student investigator.

5. Although much attention was made for choosing relevant variables for the research, a few more variables may still be missing in the research design.

Presentation of the study

The report of the study is presented in five chapters. The first chapter outlines a brief introduction, objectives, scope, and limitations of the study. The review of literature relevant to the study is cited in the second chapter. The third chapter describes the methodology followed, which has a bearing on the measurement of variables, with statistical procedures used. It is followed by the fourth chapter, which deals with the results and discussion based on the obtained results. Finally, the fifth chapter puts forth a summary and conclusions of the thesis, followed by a bibliography. The appendices and the abstract of the study are given at the end of the report.

Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

An essential component of scientific research is a thorough assessment of the literature. To identify the critical aspects of the study, the researchers must get familiar with prior work. The researcher used every available journal, book, magazine, and report to support the conclusions of the current inquiry. Efforts have been made to compile the most significant reviews of farmer innovations in agricultural machinery. However, due to the limited number of prior studies, the researcher was hard to locate reviews that were directly relevant to the topic.

Based on these insights, the pertinent literature currently accessible has been examined in light of the study's objectives. It has been highlighted under the following subheads:

2.1 Concept related to innovators and innovations

2.2 Conditions necessitating innovations

2.3 Perceived attributes of innovation

2.4 Profile characteristics of farmer innovators

2.5 Impact of farmer innovations

2.6 Role of institutions in promoting farmer innovations

2.7 Constraints in promoting farmer innovations

2.8 Strategies for upscaling farmer innovations

2.1 Concept related to innovators and innovations

2.1.1 Innovator-definition

Rogers and Shoemaker (1971) described innovators as a small agricultural community willing to try a novel idea or practice. Because innovators embrace new techniques so quickly, they often don't represent the bulk of farmers.

Hoffmann (2006) denoted an innovator as one who experiences a problem for which he would like to find a solution.

PROLINNOVA (2006) defined an innovator as someone who develops or tries out new ideas without the support of the formal extension services. “New” was defined as something that has been started within the lifetime of the farmer, not something that they inherited from parents or grandparents

Ustyuzhantseva (2015) defined farm innovators as those who often operate outside of official organizations and make innovative attempts to address local issues.

Mulyono *et al.* (2021) mentioned that innovators are open, brave farmers, like to do new things, always looking for information, have their own capital capabilities, and dare to risk failure.

2.1.2 Concept of innovation

Schumpeter (1939) explicitly examined and formulated a theory on innovation and defined it as a new combination of production inputs, which results in a new product, production method, market, raw material sources, or a new position in the market.

Rogers (1962) defined innovation as an idea, practice, or object perceived as new by an individual or the other unit of adoption. The first group of adopters of introduced technologies is referred to as innovators.

According to Lundvall (1992), innovation is a process by which a nation creates and transforms the latest knowledge and technologies into valuable products, services, and strategies for national and worldwide products prompting both value creation for stakeholders and a higher standard of living.

According to the World Bank (2006), innovation is the process by which individuals or organizations master and implement the design and manufacture of goods and services that are novel to them, regardless of whether they are new to their competitors, their country, or the whole world.

Andriopoulos and Dawson (2009) described innovation as the knowledge that may be brand new but can also involve the new use of existing knowledge. It may include both product and process innovations and, more often than not, concerns the small changes associated with incremental learning and problem-solving.

Matthias (2010) described innovation as the process through which individuals or groups within a given locality discover, develop, and apply improved ways of managing the available resources, building on and expanding the boundaries of their traditional knowledge.

Wu and Zhang (2013) defined farmers' innovation as any technology, invention, or improvement made by rural people to cope with the complexity of local resources and ecological, economic, and social conditions.

Soedjana *et al.* (2015) suggested that innovation could be a new technique involving the use of materials or tools, but it may also be just a new way of doing things.

2.2 Conditions necessitating innovations

According to Saad (2002), the execution of innovation-generation activities might be prompted by a variety of factors. These elements might be shocks, scarcity of production factors, opportunities, interactions with crucial players, coincidences, imagination, or socioeconomic elements.

Lipton (2005) pointed out that natural and purposive selections are the main processes through which agricultural innovations emerge. Technology is generated, modified, and disseminated via innovation, which is seen as a spontaneous process.

Gault and Zhang (2010) stated that innovation can be triggered in many ways, comprising radical changes and continuous improvements through many minor enhancements. Non-research and development innovation can take place by adapting existing technology or by 'learning by doing.'

Wills (2012) asserted that it is difficult to pinpoint the factors that influence farmer-led innovations. While some farmers innovated as a result of need, adversity, or opportunity, others adopted a more methodical approach to innovation, like the farmer

who evaluates prior results on a yearly basis in order to improve his agricultural operations.

Juma *et al.* (2013) opined that local farmers adapt and create innovations in light of the rapidly shifting economic circumstances.

According to Waters-Bayer *et al*. (2015), creating spaces for social learning stimulated innovation in some of the farmers and enhanced local capacity to innovate by the end of the Civil Society Organization intervention. When farmers are encouraged to work in small groups, they can tackle a wide diversity of topics, responding to heterogeneous needs in the community while sharing their newly acquired knowledge leading to innovations.

2.3 Perceived attributes of innovation

Ramchandran (1974) in his research established a positive and substantial correlation between farmers' knowledge levels and the simplicity and profitability of agricultural innovations.

Tornatzky and Klein (1982) mentioned that communicability is present if the innovation needs minimal promotion to sell, if it can be simply conveyed to others, or if it is simple to explain why utilizing this product is useful.

According to Whyte (1985), the properties of modern hybrid maize varieties such as simplicity, cost, resource base, and profitability were positively and significantly correlated with farmers' level of knowledge.

Holak *et al.* (1987) report that compatibility and relative advantage are positively correlated with communicability. They contend that acquainting themselves with the innovation via looking up information gives potential adopters more assurance that it may fit into their current lifestyle, both individually and socially.

Choubey (1991) observed in his study that the perceived attributes of physical compatibility and profitability were strongly and positively correlated with farmers' level of knowledge.

According to Moore and Benbasat (1991), the observability of innovation can be explained in terms of the observability of the benefit of innovation, the easiness of reporting the outcomes of the innovation, and the reputation of the company/firm implementing the innovation.

According to Wejnert (2002), the ease with which people may benefit from the innovation is referred to as complexity in use. Design complexity is concerned with the internal elements that finally provide the utilized value.

Rogers (2003) has identified five aspects of innovation as attributes that affect its rate of diffusion in a population to whom the innovation is relevant. He argues that the high rate of diffusion of innovation would be a feature of its 'relative advantage' over the current practice, its 'compatibility' with other aspects of the culture, its 'complexity' of understanding, its 'trialability' to experience and its 'observability' to see the results.

Singh (2020) explained that effectiveness refers to the worth of the innovations measured in terms of five attributes of innovations: relative advantage, compatibility, complexity, trialability, and observability.

2.4 Profile characteristics of farmer innovators

2.4.1 Age

According to Anil (2001), majority (68%) of the complex, diverse risk-prone area farmers belonged to the category of middle age, followed by 20 per cent under young age and 12 per cent under the old age category.

Singh *et al.* (2009) reported that the majority (68.75 %) of the respondents are 26-50 years old, while 28.75 per cent are in the age group above 51 years. Only 2.5 per cent of the respondents are young, under 25 years.

Meena (2010) indicated that 28 per cent of the organic farmers belonged to the medium-aged category, followed by 13 per cent in the old age and 9 per cent in the young age categories.

Shahzad *et al.* (2011) reported that the respondents within the age group of 18-25 years had an opinion that their yield had increased by the use of agricultural information.

Gulkari (2014) stated that half (50.91 %) of the respondents were middle age, followed by slightly less than one-third (31.82 %) being old age and nearly one-fifth (17.27 %) of them were young age.

Borate (2015) observed that slightly more than half (53.50 %) of the banana growers belonged to the middle age category, followed by 26.00 per cent and 25.00 per cent in the old and young age categories, respectively.

2.4.2 Educational status

Kamalakannan (2001) revealed that 37.5 per cent of the farmers had schooling up to the middle level and stated that education had a positive relationship with media utilization behavior.

Singh *et al.* (2009) showed that about 39.16 per cent of the respondents in his study were educated up to middle school level, while 9.58 per cent possessed a college level of education.

Omotesho *et al.* (2015) explained that 61 per cent of the respondents possessed a minimum of primary school education, and 39 per cent had no formal education.

2.4.3 Farming experience

Anil (2001) revealed that 70 per cent of the complex, diverse risk-prone area farmers had medium farming experience, followed by 18 per cent having high farming experience and 12 per cent with low farming experience.

Rajaram (2002) revealed that more than half (58.33%) of the groundnut farmers had low farming experience, followed by 31.67 per cent having medium experience and 10 per cent possessing high farming experience.

Baliwada (2017) inferred that concerning farming experience, there was no significant difference between innovators (mean=30 years) and non-innovators (mean= 30.02 years).

2.4.4 Annual Income

Mande and Thombre (2009) indicated that 25 per cent of the farmers had low income, 45 per cent were medium income, and 30 per cent had a high income.

Basanayak and Manjunath (2013) in their study on the profile of awardee farmers in North Karnataka and reported that, majority of the respondents (62.50%) were in 'high' income group followed by 19.16 per cent in 'low' income group and 18.33 per cent in 'medium' income group.

Baliwada (2016) reported that the majority of the innovative farmers lie in the category of high annual income (Rs 4,54,000) than non-innovators (Rs 2,42,000). Further return per unit of land is also high for innovators.

2.4.5 Occupational status

Rao *et al.* (1989) in his study concluded that non-farm occupations provided year round employment and significant income to small and marginal farmers

Pauline and Karthikeyan (2015) in their studies reported that nearly two–third of the farmers (67.74%) had agriculture as their major occupation followed by agriculture + allied activities (16.10%). A meagre proportion of the respondents worked in agriculture + service sector (6.50%) and agriculture +business (9.66%).

Singh (2020) observed that the majority of the farmers (60.00%) had farming as their sole occupation followed by farming +business (30.00%) and service +farming (10.00%).

2.4.6 Innovativeness

Bhagyalakshmi *et al.* (2003), in their study on the profile of rural women micro-entrepreneurs, observed that the majority (69.44%) of the respondents had medium innovativeness, while 15.56 and 15.00 per cent of respondents had high and low innovativeness, respectively.

Nagesha (2005), in a study on vegetable seed-producing farmers in the Haveri district of Karnataka, reported that the majority (63.30 %) of the respondents had medium innovativeness and the farmers with low and high innovativeness were 18.30 per cent under both categories.

According to the study conducted by Taufiq *et al*. (2011), a majority (69.17%) of the respondents had a medium level of innovativeness towards the developmental activities and new technologies in the agri-enterprise, while nearly 20 per cent respondents showed a high level of innovativeness, followed by 11.67 per cent who showed a low extent of innovativeness towards new technologies or developmental activities of the agri enterprise.

Gulkari (2014) revealed that most (62.73%) of the drip-irrigated banana growers had a very high level of innovation proneness, followed by 37.27 per cent of them with a high level of innovation proneness.

Borate (2015) found that the majority (55.50 %) of the banana growers had high innovativeness. Less than two-fifths (37 %) of them had medium innovativeness, and 7.50 per cent had low innovativeness.

2.4.7 Information-seeking behavior

According to the study conducted by Sonawane *et al.* (2001) on the utilization of communication sources by farmers for seeking farm information and revealed that among the personal localite sources, 90.62 per cent of chosen friends as the primary source of information for the farmers, followed by neighbors, relatives and progressive farmers. Whereas, among the personal cosmopolite sources majority (96.87%) approached agricultural assistants as the main source of information followed by university scientists, agricultural officers and subject matter specialists.

Manjula (2003), in her study on analysis of the behavior of 'Krishi prashasthi' awardees and their influence on the neighboring farmers and reported that 55.56 per cent of the awardee farmers consulted the assistant agricultural officer regularly,

followed by the Assistant Director of Agriculture, Agriculture Assistants, televisions, scientists of UAS, newspapers, input agencies and progressive farmers.

Neethi and Sailaja (2013) indicated that the majority (56.67%) of the respondents had medium information-seeking behavior, followed by 25.83 percent having high and 17.50 per cent with low information-seeking behavior.

2.4.8 Scientific orientation

Karpagam (2000) conducted a study on the knowledge and adoption of farmers cultivating turmeric and reported that the majority (75%) of the respondents were in the medium category, followed by 13.33 per cent in the low category and 11.67 per cent in the high category for scientific orientation.

Anil (2001) opined that the majority (66%) of the complex, diverse, and risk-prone area farmers had medium scientific orientation, followed by 18 per cent with a high and 16 per cent with low scientific exposure.

Vasantha (2002) inferred that the majority (38.57 %) of the cotton-growing farmers fell under the medium category, followed by 35.71 per cent and 25.72 per cent falling under high and low scientific orientation, respectively.

Basanayak (2012) reported that 56.67 per cent of the awardee farmers in northern Karnataka belonged to the medium scientific orientation category, whereas 29.17 and 14.17 per cent of respondents were observed in the high low scientific orientation category, respectively.

Basanayak *et al.* (2013), in their study on the profile of awardee farmers in North Karnataka, reported that 56.67 per cent of the awardee farmers belonged to the medium scientific orientation category, whereas 29.17 and 14.17 per cent of them were observed in high and low scientific orientation category, respectively.

2.4.9 Risk-bearing ability

Dhamodharan and Vasanthakumar (2001) revealed that the majority of the respondents (81.67%) had a medium level of risk orientation, followed by 18.33 per cent of the respondents with a high level of risk orientation.

Kumar (2002) revealed that 45 per cent of the small farmers had a low-risk orientation, followed by 40 per cent having medium and 15 per cent with a high-risk orientation.

Bhagyalakshmi *et al*. (2003), in their study revealed that the majority of the respondents (75.56%) had medium risk-taking ability followed by low (15.56%) and high (13.33%) risk-bearing ability.

Manjula (2003), in her study on analysis of the behavior of krishi prashasthi awardees and their influence on the neighboring farmers and reported that more than half (55.56%) of awardee farmers belonged to the category of high-risk orientation, about one-third (33.33%) belonged to the medium and about one-tenth (11.11%) belonged to low-risk orientation category.

Shilpashree (2011) conducted a profilistic study on awardee farmers in North Karnataka and reported that 45 per cent of the awardee farmers belonged to the high-risk orientation category, followed by medium (32.50%) and low (22.50%) risk orientation category, respectively.

2.4.10 Extension contact

Anil (2001) indicated that the majority (60%) of the complex, diverse, and risk-prone area farmers had medium extension contact followed by low (28%) and high (12%) extension contact.

Anitha (2004) reported in her study that 17.50 per cent of respondents had high extension participation, 44.20 per cent had medium, and 38.30 per cent had low extension participation.

Bhatt (2006) found that nearly three-fourths (73.50 %) of dairy farmers had a medium level of extension contact, followed by 8 per cent with a high level of extension contact and 18.50 per cent with a low level of extension contact.

2.4.11 Economic motivation

Dhakar (2009) reported that the majority of the farmers (63%) were in the medium economic motivation category, followed by high economic motivation (29%). About 8 per cent were in the low economic motivation category. The mean score of the low economic motivation category was found to be 0.08, while that of the medium economic motivation category was 1.26 and 0.87 for the high economic motivation category, respectively.

Shankaraiah and Swamy (2012) reported that 47 5 per cent of the farmers had a medium level of economic motivation. One of the reasons for this might be that farmers are becoming more and more market-oriented to get more profit

Shivacharan (2014) reported that a significant portion (43.33%) of the respondents had a high level of economic motivation, followed by 32.50 per cent belonging to medium, 20 per cent low, and 4.17 per cent had a very low level of economic motivation.

Yadav (2014) reported that a higher number of beneficiaries (37.14%) was found medium category of economic motivation, followed by high economic motivation (34.29 %) and low economic motivation (28.57 %). On the other hand, data showed that a higher number of the non-beneficiaries, 41.43 per cent, were in the medium economic motivation group, followed by 32.86 per cent in the low economic motivation group and 25.71 per cent in the high economic motivation group.

2.4.12 Self-confidence

Thorat (2005) reported that more than two- third (69.33 per cent) of the poultry farmers had a medium level of self-confidence, whereas 17.34 per cent had a high level of self-confidence and 13.33 per cent with a low level of self-confidence.

Avhad *et al.* (2015) revealed that the majority (56.67%) of the respondents had medium self-confidence, trailed by low (3.33%) and high (40%) self-confidence. It implied that they were more sure about their capacities to enhance their dairy venture. This confidence might be expected in their accomplishment in dairy undertaking with getting higher income.

Porchezhiyan *et al.* (2016) reported that 77.50 per cent of the farmer entrepreneurs had high self-confidence, 15.80 per cent low, and 6.70 per cent had medium self-confidence.

2.5 Impact of farmer-led innovations

Sunding and Zilberman (2001) concluded that the analysis of adoption or the impact of risk-reducing innovations might require incorporating a risk-aversion consideration in the modeling framework, while investigating the economics of a shelf-life enhancing innovation may require a modeling framework that emphasizes inter-seasonal dynamics.

According to Mapila *et al*. (2011), farmer-led innovation strongly impacts some aspects of rural livelihoods, with more substantial positive effects on income and crop production.

Mapila *et al.* (2012) reported that agricultural innovations positively impact women's empowerment, income, and assets accumulation of rural households in Malawi and Uganda

Wunscher (2014) reported that the majority of the cutting-edge practices cited by farmers are yield-related (e.g., crop and crop varieties, soil fertility, and pest and disease control). Therefore, it is not surprising that higher productivity is the result that is most often highlighted. The farmers listed high income and food security as other crucial goals. These two results, which are both connected to higher productivity, highlight the potential advantages of farmer innovation for human welfare. Farmers also cite labor savings as a benefit that lowers production costs and frees up workers for employment outside the farm.

Waters-Bayer *et al.*(2015) stated that most of the farmer-led research involved reduced use of chemical inputs and had a positive environmental impact.

2.6 Role of institutions in promoting farmer-led innovations

Concerted efforts are being made to involve farmers as effective partners in evolving technologies, not merely for adopting and adapting lab-based technologies but also to encourage them as innovators for location-specific technologies and for upscaling those innovations (ICAR, 2010).

According to Akkoyunlu (2013), institutional innovations are required to connect farmers to knowledge and information. It can help strengthen the linkages between the various stakeholders, such as farmers, governments, researchers, and businesses, to promote innovations.

The database of all the registered varieties in the PPV&FR Authority is maintained in a register known as the National Register of Plant Varieties. The same database is also kept in digital form in the e-National register. This software can search data by registration number/crop name/ denomination and generate a report. There are many important entries like registration number, nationality of the breeder, date of grant of registration certificate, denomination as granted, date of gazette notification, essential characters making the variety distinct, etc., in this software. The data backup of this software can be taken in any external storage device (PPVFRA, 2014)

A database of more than 2,11,600 technical concepts, innovations, and traditional knowledge practices from more than 575 districts around the nation has been compiled by NIF. NIF has honored over 775 local innovators and school children at the national level via its numerous award ceremonies. Pro bono arrangement with patent firms has helped NIF to file over 743 patents (including eight filed in the USA and twenty-seven PCT applications) on behalf of the innovators and outstanding traditional knowledge holders, of which 37 patents have been granted in India and 5 in the USA. It has also filed applications for 29 farmers' developed plant varieties at the PPV&FR Authority. NIF has received over 600 product inquiries from around 55 countries for various technologies and has succeeded in commercializing products across countries

on six continents apart from being successful in materializing 89 cases of technology licensing (NIF, 2015).

Farmers must have access to cutting-edge technology, essential inputs, and relevant information to reach their full potential. This is why the Indian government, through ICAR, established a vast network of over 600 Krishi Vigyan Kendras (KVKs) throughout the nation to perform interdisciplinary technology evaluation and refinement, information dissemination, and critical input assistance for farmers with a multidisciplinary approach (CPCRI, 2018).

In rural areas, innovations are often tailored to needs arising from a population. It is usually developed with locally available sources. It was found that there are limitations in such research. To resolve them and develop them in a marketable manner Kerala Science, Technology, and Environment Council implemented the necessary projects for upscaling such innovations (Kumar, 2021).

2.7 Constraints in developing farmer innovations

Mendoza (1999) believed that when confronted with obstacles in carrying out agricultural operations, farmers attempt to develop or accept already-existing local innovations based on the resources available.

According to Sunding and Zilberman (2001), technological advancement is driven by agroecological traits and governmental regulations, which emphasize advantages over disadvantages as an incentive for innovation. The argument is that opportunities connected to economics and markets, agroecological conditions, and government regulations, as well as factor scarcities, influence innovation in an area.

Sagufta (2007) observed that the most essential economic constraints faced by the dairy farm women in the adoption of dairy innovations were: high rates of interest on loans, high cost of milch animals, short duration of loans, high cost of construction for cattle shed and lack of loan facility.

Sanginga *et al.* (2009) reported that rural farmers are reportedly getting more innovative in response to growing difficulties. They conduct informal experiments,

create new technology, and alter or modify external innovations to fit their local surroundings.

Jalal-ud-Din (2011) revealed that the primary issues confronting the small farmers in the study area were a lack of access to the latest information and a lack of financial facilities.

Brigidletty *et al.* (2012) reported that there is no appreciation of farmers as actors in the innovation system, little information provided about different sources of knowledge involved, nor the flow of knowledge, and little attention to long-term impacts on livelihoods.

2.8 Strategies for scaling up farmer innovations

Sunding and Zilberman (2001) reported that the inducement of innovations also requires specific policies and institutions that provide resources to would-be innovators and enable them to reap the benefits from their innovations. Patent protection is probably the most obvious incentive for innovation activities. Discoverers of new patentable technology have the property right for its utilization for a well-defined period of time, and an alternative tool may be a prize for the discoverer of new technology.

Nelson (2008) argued that the economic, social, and legal systems and institutions should encourage entrepreneurship for innovation-induced economic growth.

Gupta (2009) mentioned that a national fund is required under which farmers will have a right to demand research from public institutions. This fund should target all crops, livestock species, trees, and value-added products developed by innovative farmers or groups for solving technological and resource use problems.

PROLINNOVA (2009) suggested that although not all innovations require further research, existing successful farmer innovations are worthy of wider dissemination. Researchers and farmers should collaborate in participatory research to find answers to specific problems, build on existing knowledge and verify farmers' innovations for effectiveness and safety.

According to Geraldo *et al.* (2010), a designated critical analysis conference on innovations should meet yearly with external advisors as feedback to farm innovators and research teams.

Gupta (2013) mentioned that many farmers have benefited from the Honey Bee Network's open-access database of innovations. However, if the database is translated into several languages and extensively disseminated through social media platforms, many more people might profit. The innovators' identities should be honored, and their intellectual property rights must be safeguarded. Similarly to this, a lot of folk cultural innovation exists and should be appreciated in order to preserve experimental and innovative traditions. One has to establish avenues for documentation and entrepreneurial growth for each of them.

Abdullahi *et al.* (2014) reported that scientists were encouraged to support farmers in the development of their innovations so that local innovations would be appreciated by fostering an accepting environment at all levels. Farmers should be encouraged to discuss ideas in order to better understand their agricultural situations and potential solutions. The agricultural and rural development of the region would benefit from encouraging farmers to innovate and modify formal (exogenous) innovation.

Research methodology

CHAPTER 3

RESEARCH METHODOLOGY

Research methodology has been defined as the systematic and theoretical analysis of the procedures applied in the field of study. Methods and techniques used in the study are described in this chapter. The various data collection tools and analytical methods employed in the study are also covered in this chapter. The details of all these were outlined under the following subheadings:

3.1 Research design

3.2 Locale of the study

3.3 Selection of the respondents

3.4 Measurement of independent variables

3.5 Operationalization and measurement of dependent variables

3.6 Stages of innovation development

3.7 Statistical tools used in the study

3. 1 Research design

The research design refers to the overall strategy and analytical approach that the researcher has chosen to integrate, coherently and logically, the different components of the study, thus ensuring that the research problem will be thoroughly investigated. In the present research, an *ex-post facto* research design was used.

Ex-post facto research design is an organized empirical investigation in which the independent variables have not been actively handled because they have already occurred or are intrinsically not manageable.

3.2 Locale of the study

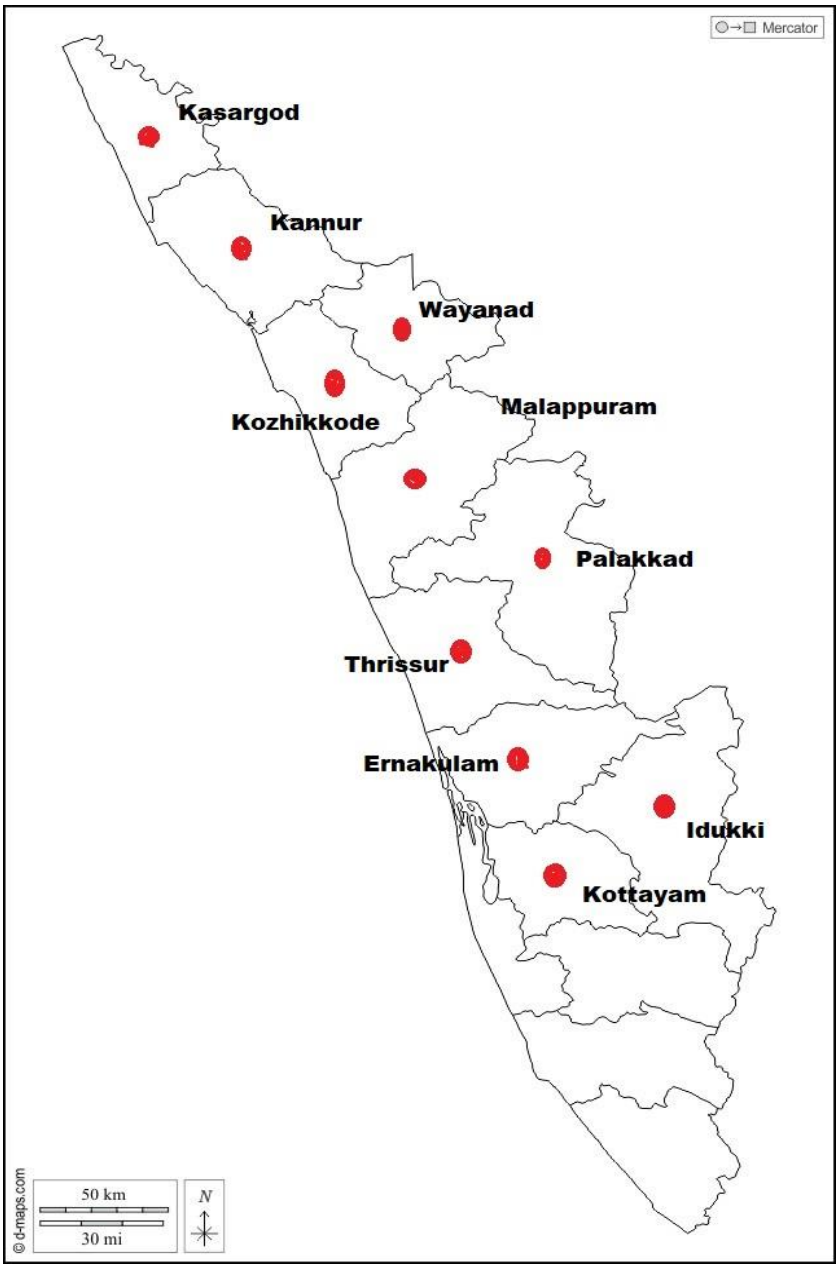


Figure 3.1 Map showing study locations in Kerala

In this study, the state of Kerala was purposively selected for conducting the research. Farmer innovators who have developed machinery in the field of agriculture form the primary respondent group of the study. Since they spread throughout the state, the whole state of Kerala was included for the study.

3.3 Selection of Respondents

The study comprises of three categories of respondents. The first category involves the farmer innovators. Those farmers who have an inherent aptitude for developing innovations and those who have developed atleast one machinery in the field of agriculture were included under this category. The sample size under this category was taken as 30 farmer innovators. To identify these 30 farmer innovators, the publications of the National Innovation Foundation (NIF), Kerala State Council for Science Technology and Environment (KSCSTE), Agri-Business Incubator (ABI) under Kerala Agricultural University (KAU), and institutions relevant to this area were considered.

The second category of respondents is the innovation facilitators. These people have knowledge about the farmer innovators for a long time and are constantly associated with them. These people were identified after selecting the farmer innovators and having a preliminary discussion with them. A total of 30 innovation facilitators, one for each innovation, were chosen for the study.

The third category of respondents is the expert group for judging the listed innovations. Based on the purposive sampling, 30 experts who have worked in farmer innovation development were identified. The respondents comprise researchers, extension workers, and progressive farmers.

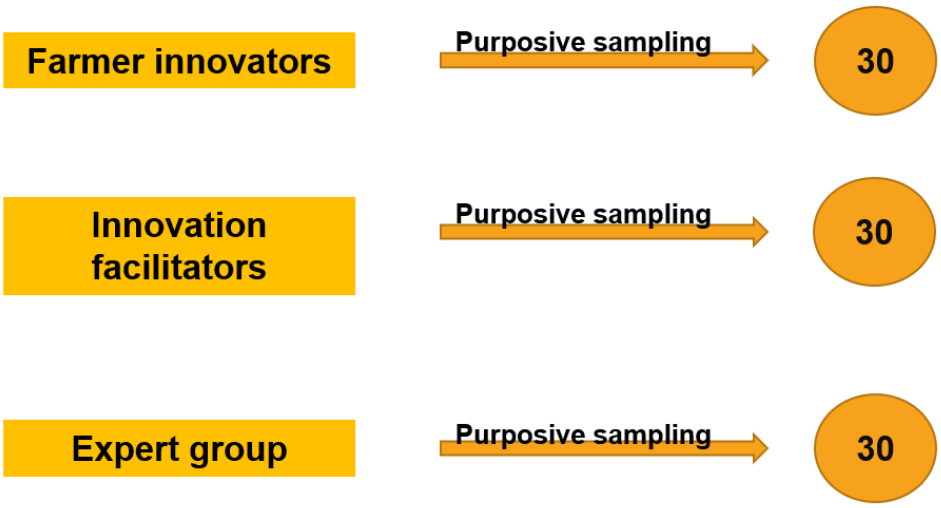


Figure 3.2 Selection of respondents

3.4 Independent variables and their measurement

A total of fifteen independent variables were selected for the study based on the judges ratings. The measurement of these variables was carried out through appropriate tools in consultation with experts.

The selected independent variables were:

1. Age
2. Educational status
3. Farming experience
4. Industrial experience
5. Annual income
6. Occupational status
7. Innovativeness
8. Information-seeking behavior
9. Scientific orientation
10. Risk-bearing ability
11. Extension contact
12. Institutional support
13. Economic motivation
14. Self-confidence
15. Source of finance

3.5 Operationalization of independent variables

3.5.1 Age

Age was measured by considering the chronological age of the respondents at the time of the investigation. Depending on the age of the respondents, they were grouped into three categories. The procedure followed by the census of India (Government of India, 2011) was adopted for the purpose.

Table 3.1 Procedure for scoring age

Sl. No	Categories	Score
1	Young (upto 35 years)	1
2	Middle (36 to 50 years)	2
3	Old (51 years and above)	3

3.5.2 Educational Status

The educational status was measured in terms of the years of formal education undergone by the respondents. The respondents were categorized into different groups based on their educational status. Each group was given scores as below:

Table 3.2 Procedure for scoring educational status

Sl. No.	Categories	Scores
1	High School	1
2	Higher Secondary	2
3	Graduation/Diploma/ITI	3

3.5.3 Farming Experience

Farming experience can be defined as the number of years an individual had experience in farming and allied activities at the time of data collection. The categorization was done by taking the standard deviation and mean as check. Hereafter, the respondents are grouped into three categories.

Table 3.3 Procedure for scoring farming experience

Sl. No.	Categorization	Score
1	Low experience (Less than Mean- SD)	1
2	Medium experience (In between Mean ± SD)	2
3	High experience (More than Mean + SD)	3

3.5.4 Industrial Experience

Industrial experience refers to the years a respondent had spent and knowledge gained from working in a particular industry or sector of the economy. The categorization of farmers was developed by taking the standard deviation and mean values and grouped into three categories.

Table 3.4 Procedure for scoring industrial experience

Sl. No.	Categorization	Score
1	Low experience (Less than Mean- SD)	1
2	Medium experience (In between Mean ± SD)	2
3	High experience (More than Mean + SD)	3

3.5.5 Annual income

Annual income was operationalized as the total income in rupees obtained by the respondent's family from different sources like crops, animal husbandry enterprises, salary, wages, business, and other sources in a year. The entire income obtained from all the sources by the respondent was considered. Hereafter, the respondents were categorized into low, medium, and high income groups based on the classification followed by Danagoudar (2016).

Table 3.5 Procedure for scoring annual income

Sl. No.	Categories	Income (Rs./annum)	Score
1	Low	Less than Rs. 2,00,000	1
2	Medium	Rs. 2,00,000 to 5,00,000	2
3	High	More than Rs. 5,00,000	3

3.5.6 Occupational status

Occupational status refers to the work done by the farmer innovator to earn a livelihood. Respondents were categorized into four occupational groups: Farming, Farming+labour, Farming+service, and Farming+business and scores were assigned for their classification.

Table 3.6 Procedure for scoring occupational status

Sl. No.	Categories	Score
1	Farming	1
2	Farming+labour	2
3	Farming+service	3
4	Farming+business	4

3.5.7 Innovativeness

It was operationally defined as the individual interest in finding and trying out new things. The scale developed by Archana (2013) was used to measure innovativeness. It consists of five statements, out of which two are negative. The positive statements were assigned the scores 5, 4, 3, 2, and 1 for strongly agree, agree, undecided, disagree, and strongly disagree, respectively. The reverse order of scoring was followed in case of negative statements. The total score was obtained by summing up the individual scores. The respondents were grouped into three categories, namely low innovativeness, medium innovativeness, and high innovativeness, based on the mean and standard deviation.

Table 3.7 Procedure for scoring innovativeness

Sl. No.	Categories	Class range	Score
1	Low innovativeness	Less than (Mean-SD)	1
2	Medium innovativeness	In between (Mean ± SD)	2
3	High innovativeness	Greater than (Mean+SD)	3

3.5.8 Information-seeking behavior

The information-seeking behavior of a farmer was operationally defined as the frequency of contact of farmers with various sources of information. The scale contained three information sources: informal, formal, and mass media. Respondents were categorized based on their responses into five categories as follows:

Table 3.8 Procedure for scoring information-seeking behavior

Sl. No.	Categories	Score
1	Formal sources	1
2	Informal sources	2
3	Formal+informal+mass media	3
4	Formal+informal	4
5	Formal+mass media	5

3.5.9 Scientific orientation

It is defined as the degree of orientation of the respondents towards the use of scientific methods in agriculture. The variable was measured by using the scientific orientation scale of Supe (1969) with suitable modifications. The scale has five statements with three response categories, 'Agree,' 'Undecided,' and 'Disagree,' for five statements. A score of three was assigned to the 'Agree' response, a score of two for the 'Undecided,' and one score for the 'Disagree' response. A reverse scoring procedure was followed in case of negative statements. The total score ranged from 5 to 15. The mean and standard deviation were used as a measure of check to categorize the level of scientific orientation as shown below.

Table 3.9 Procedure for scoring scientific orientation

Sl. No.	Category	Class range	Score
1	Low	Less than (Mean-SD)	1
2	Medium	In between (Mean ± SD)	2
3	High	Greater than (Mean+SD)	3

3.5.10 Risk-bearing ability

It refers to the degree to which the respondent is oriented towards risk and uncertainty and has the courage to face the problem. This was measured by the risk preference scale followed by Baliwada (2017) with necessary modifications. The responses were recorded on a four-point scale. The maximum score an individual could get was 16, and the minimum was 4. The scores on all the statements were added to arrive at the total score for an individual. The scoring for 'Strongly agree', 'Agree', 'Disagree' and 'Strongly Disagree' was assigned as 4,3,2 and 1 respectively. The innovators are then classified into three categories, i.e., the ones with low, medium, and high risk-bearing ability.

Table 3.10 Procedure for scoring risk-bearing ability

Sl. No.	Categories	Class range	Score
1	Low risk-bearing ability	Less than (Mean-SD)	1
2	Medium risk-bearing ability	In between (Mean ± SD)	2
3	High risk-bearing ability	Greater than (Mean+SD)	3

3.5.11 Extension contact

This was operationally characterized as the extent of contact with various institutions and agencies by the farmer during the innovation development. The contact by the farmer was classified into 'frequently', 'occasionally,' and 'never,' and the total score obtained was used to classify innovators into three groups based on the mean and standard deviation scores obtained. A score of 1 was given to farmers with low extension contact, 2 to medium extension contact, and 3 with high extension contact.

Table 3.11 Procedure for scoring extension contact

Sl. No.	Categories	Class range	Score
1	Low extension contact	Less than (Mean-SD)	1
2	Medium extension contact	In between (Mean ± SD)	2
3	High extension contact	Greater than (Mean+SD)	3

3.5.12 Institutional support

This refers to the support received from various institutions to the innovators during their entire course of development of the innovation. It helps to realize the extent of the approach of the farmer innovators towards various institutions for accessing support. Various institutions providing support were taken and scored accordingly, and the number of farmers who approached these institutions to get support was analyzed.

Table 3.12 Procedure for scoring institutional support

Sl. No.	Categories	Scoring
1	Agricultural research institutions	1
2	Department of Agriculture and Farmer's welfare	2
3	Technical Institutions	3
4	Other supporting agencies	4

3.5.13 Economic motivation

It refers to occupational success in terms of profit maximization and the relative values individuals place on economic ends. The scale has five statements: three were positive, and two were negative. It was measured on a four-point continuum, such as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree', appraised with weightage of 4, 3, 2, and 1 for positive statements and 1, 2, 3, and 4 for negative statements, individually. The most extreme and least scores extended in the vicinity of 20 and 5, respectively. Based on the scores received, the innovators were classified into three based on their mean and standard deviation scores.

Table 3.13 Procedure for scoring economic motivation

Sl. No.	Category	Class range	Range of scores
1	Low	Less than (Mean-SD)	1
2	Medium	In between (Mean ± SD)	2
3	High	Greater than (Mean+SD)	3

3.5.14 Self confidence

This refers to the belief of the respondent farmers in their abilities, initiative, and zeal to achieve their goals or aims. This variable was measured by the scale followed by Seema (1997) with slight modifications. The scale consisted of five statements, with two positive and three negative statements. The response was obtained on a four-point scale, namely 'Strongly Agree', 'Agree', 'Disagree', and 'Strongly disagree', with a weightage of 4,3,2,1 respectively, for positive statements. The scoring procedure was reversed for negative statements. The possible scores varied from 5 to 20.

Table 3.14 Procedure for scoring self confidence

Sl. No.	Category	Class range	Range of scores
1	Low	Less than (Mean-SD)	1
2	Medium	In between (Mean ± SD)	2
3	High	Greater than (Mean+SD)	3

3.5.15 Source of finance

The source of finance corresponds to the various financial agencies that the innovator has approached for accessing credit or loans for upscaling his innovation. Support received from multiple agencies was taken and scored accordingly. The number of farmers who approached these institutions to get support was also analyzed.

Table 3.15 Procedure for scoring source of finance

Sl. No.	Source of finance	Score
1	Nationalized banks	1
2	Cooperative banks/societies	2
3	Private agencies/relatives	3
4	Own investment	4

3.6 Operationalization of dependent variable

The attributes of innovation were identified as the dependent variable for the study. These innovation attributes were identified from the studies by Rogers (1983) and Flight *et al.* (2011). The dimensions of the selected dependent variable are as follows:

3.6.1 Relative advantage

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. It consisted of three positive statements, and responses were obtained as 'Strongly agree,' 'Agree,' 'Disagree,' and 'Strongly disagree' with scores of 4,3,2,1, respectively. The total score was computed by summing up each response and was grouped into three categories.

3.6.2 Observability

Observability is the degree to which the results of an innovation are visible to others. This attribute consisted of three positive statements, and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 4,3,2,1, respectively. The total score was computed by summing up each response, and they were grouped into three categories based on mean and standard deviation. The total score for observability ranged from 3 to 12.

3.6.3 Compatibility

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. The measurement consisted of three positive statements and responses were obtained as

'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree', and scores ranging from 4 to 1 were assigned. The total score was computed by summing up each response, and they were categorized into three based on mean and standard deviation. The total score for compatibility ranged from 3 to 12.

3.6.4 Complexity in use

Complexity in use refers to the ease with which users derive value from the innovation. The measurement consisted of three negative statements and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 1,2,3 and 4 respectively. The total score was computed by summing up each response, and they were grouped into three categories based on mean and standard deviation.

3.6.5 Complexity in design

Complexity in design deals with internal components that ultimately create the value used in the innovation. The measurement consisted of three negative statements and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 1,2,3 and 4 respectively. The total score was computed by summing up each response, and based on mean and standard deviation, they were grouped into three categories.

3.6.6 Discontinuity

Discontinuity is described as the process in which the innovation changes or stops another innovation rather than continuing in the same way. The measurement consists of three positive statements and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 4,3,2 and 1 respectively. The total score was computed by summing up each response, and they were grouped into three based on mean and standard deviation.

3.6.7 Communicability

Communicability is emphasized in the mass communication media and exists if the benefits of the innovation can easily be explained to potential adopters via mass communication or by any other means. The measurement consisted of three positive

statements and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 4,3,2,1 respectively. The overall score was computed by summing up each response and was grouped into three categories based on mean and standard deviation.

3.6.8 Trialability

Trialability is the degree to which an innovation may be experimented with on a limited basis. The measurement consisted of three positive statements, and responses were obtained as 'Strongly agree', 'Agree', 'Disagree', and 'Strongly disagree' with scores of 4,3,2,1, respectively. The total score was computed by summing up each response, and they were categorized into categories based on mean and standard deviation

3.7 Measurement of attributes of innovation

The scale developed by Flight *et al.* (2011) was adopted with suitable modifications for measuring the attributes of innovation. Each attribute of innovation has three statements. The innovation facilitators were asked to rate the statements representing selected dimensions with scores of 4,3, 2 and 1 in the case of positive statements. The scoring procedure was reversed for negative statements. The maximum score for each attribute is 12, and the minimum score is 3.

The attributes of the innovation of the farmer innovators were compared using the composite index method followed by Aiswarya (2016) with slight modifications. The procedure used for calculating the attribute score and index is as follows:

$$\text{Attribute score} = \frac{\text{Score given by the facilitator for the attribute}}{\text{The maximum possible score of the attribute}} \times 100$$

$$\text{Attribute index} = \frac{\sum X}{M \times S}$$

$\sum X$ = sum total scores of all the attributes

M = Maximum scores of all the attributes

S = Total number of statements

3.8 Stages of innovation development

A series of processes that take an idea from conception to commercialization is known as the innovation development process. According to Leurs and Duggan (2018), it consists of 5 phases of development as follows:

1. Proof of concept (POC)/Ideation

2. Prototype

3. Pilot/Minimum Viable Product (MVP)

4. Production

5. Commercialization

In this study, the innovations were grouped into four categories based on their current stage of development as follows:

Table 3.16 Procedure for scoring stage of innovation development

Sl. No.	Stage of development	Score
1	Upto prototype stage	1
2	Upto minimum viable product stage	2
3	Upto production stage	3
4	Upto commercialization stage	4

3.9 Methods used for data collection

The data required for the study was collected using a structured interview schedule and adopting various participatory data collection tools. A structured interview schedule was developed based on the primary objectives of the study. The variable selection for preparing the interview schedule was based on judges rating with expert extension professionals. The respondents were interviewed physically in most cases and through the telephonic process in some cases. The interview schedule used for primary data collection is given in Appendix 1.

The case study of individual farmer innovators was prepared, and these cases were circulated among the expert group for evaluation. A separate questionnaire was designed for this purpose. Secondary data were collected through a review of reports, scheme papers, documents and other materials from different websites.

3.10 Statistical tools used in the study

The data obtained through the interview schedule was examined and scored using the software tool Statistical Package for Social Sciences (SPSS version 26). The various statistical tools used for the study include:

3.10.1 Arithmetic mean

It is computed by dividing the sum of their individual values by the total number of observations and denoted by the letter X.

3.10.2 Standard deviation

Standard deviation estimates how much a set of values differs or how scattered these values are. It is represented as the positive square root of the mean of the squared deviations from the arithmetic mean. It is symbolized by σ.

3.10.3 Frequency distribution and percentages

The frequency distribution and percentages have been used to determine the distribution pattern of respondents in relation to the selected variables. In order to standardize the sample, percentages were used to estimate how many individuals would fall into each group.

3.10.4 Chi-square test

The relationship between the dependent variable and independent variables was studied by utilizing the chi-square test as follows:

$$\mathbf{X^2} = \sum \frac{(\boldsymbol{Oi}-\boldsymbol{Ei})^2}{\boldsymbol{Ei}}$$

With d.f.= (r-1) (c-1)

Where,

Oi = Observed frequency of respondents under study

Ei = Expected frequency of the respondents under study

r = No. of rows

c = No. of column

3.10.5 Kendall's coefficient of concordance (W)

It was used to determine the association among K sets of rankings. To compute 'W', the sum of ranks (Rj) in each column of a K/N table is found. W is computed using the formula

$$\mathbf{W=}\frac{\boldsymbol{12S}}{\boldsymbol{K2(N3-N)}}$$

S = sum of squares of the observed deviations from the mean of Rj.

Where S= $\sum (Rj - \sum \frac{Rj}{N})^2$

K= number of rankings

N= no of units or objects ranked

3.10.6 Garett ranking

We have used the Garret ranking technique to find out the significant constraints in promoting farmer-led innovations. The constraints were divided into four categories: technical, infrastructural, economic, and administrative. Then, the Garrett ranking technique was used to identify the major statements. In the Garett ranking method, the rank assigned to different statements was converted into a percentage using the following formula described below.

Per cent position= $100(R_{ij} -0.5) / N_j$

Where R_{ij}=Rank given for i^{th} factor by j^{th} individual

N_j = number of factors ranked by j^{th} individual

Here 0.5 is subtracted from each rank because the rank is an interval on a scale, and its midpoint best represents the interval. Then the percentage positions were converted into scores on a scale of 100 points, referring to the table given by Garett and Woodworth (1969). The mean score level was derived from the obtained scores, and constraints were ranked based on the mean score level.

3.10.7 Spearman's rank correlation coefficient

Spearman's rank correlation coefficient method is a non-parametric statistical method mainly used to evaluate the relationship between the independent and dependent variables. The Spearman's rank correlation coefficient is obtained using the equation:

$$\mathbf{r_s = 1-\frac{6\sum di^2}{n(n^2-1)}}$$

Where n= number of pairs of observation

d = difference of rank between the paired elements in the two sequences.

Results and discussion

CHAPTER 4

RESULTS AND DISCUSSIONS

The results and discussions presented here specify the overall results obtained from the study under various objectives. The data obtained from the documentation of farmer innovations and the responses from the innovation facilitators and the expert group were analyzed. The findings and discussions based on the related results from various literatures and the existing theories are presented here. The results in the chapter are comprehensively arranged under the following sub-headings.

4.1 Documentation of farmer innovations in the area of agricultural machinery

4.2 Reason for development of the innovations

4.3 Time taken for innovation development

4.4 Stages of innovation development

4.5 Analysis of farmer profile characteristics

4.6 Attributes of the farmer innovations

4.7 Analysis of attributes of farmer innovations with innovation stages

4.8 Relationship of independent variables with attributes of farmer innovations

4.9 Study of perceived attributes by the expert group

4.10 Constraints faced by farmers in promoting farmer innovations

4.11 Institutional support received for the development of farmer innovations

4.1 Documentation of farmer innovations in the area of agricultural machinery

This section deals with the documentation of 30 selected farmer innovations from various parts of the state associated with the agricultural machinery sector.

4.1.1 Automatic tender coconut peeling machine

Innovator: Sijoy Chandran, Kunnampullil House, Kanjani P.O, Thrissur

Sijoy Chandran (43), a Thrissur District native, has created an automatic tender coconut peeling machine as a significant contribution for supporting tender coconut vendors. With this new machine, even after peeling the fragile coconut, users can safely keep it. After researching its scope, Sijoy was granted a patent for the automatic tender coconut peeling machine. In the early 2000s, Sijoy saw street merchants straining to hand peel the tender coconuts. They risked their hands, and their outdated instrument was also unattractive, prompting Sijoy to develop a mechanical method for efficiently, easily, and noticeably peeling fragile coconuts. The machine has 100mm blades that can remove the coconut shell in 40 seconds. The machine, under the production stage, can cut the semi-hard coconut coating into 1mm pieces and be used as cattle feed. It took ten years to devise this machine, which peels one tender coconut in seconds.

Kerala Agricultural University's RAFTAAR Agri Business Incubator (KAU RABI) recognized the effort and selected 'Koocos Industries', his startup, as one of the top 3 startups. The central government granted the innovation Rs. 25 lakhs through Rashtriya Krishi Vikas Yojana under Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY-RAFTAAR) Programme.

4.1.2 Poultry litter raking machines for small farms

Innovator: Suresh P.V, Palakkattuparambil House, T.K Colony P.O, Pookkottumpadam, Malappuram

Suresh P. V. (44), a school dropout, created a cutting-edge poultry litter raking machine that might help farmers who raise poultry on a large scale. Farmers must rake the sawdust used as flooring material daily with the bird droppings. This is a labour-intensive task and prevents the birds from moving about freely.

Suresh's machine is thought to be a creative solution to this issue. This device is a miniature version of the rotavator used in paddy fields. The wheel is non-sticky and produces no dust, which helps fowl growth.

Now in the commercializing stage, the machine utilizes a 1.5 HP electric motor with a gear mechanism to regulate rotation. With specifically crafted tires that make machine operation easier, the 24-inch long machine is built for simple movement. Compared to other machines used for the same task, the technology can save 90 percent of the time and nearly 75 percent of the cost.

The startup of the innovator, 'Agromech Innovation' was selected under the Rashtriya Krishi Vikas Yojana- Remunerative Approaches for Agriculture and Allied Sector Rejuvenation Agri Business Incubator (RKVY-RAFTAAR ABI) under Kerala Agricultural University (KAU) with a support of 25 lakhs. Also, organizations, including the National Innovation Foundation (NIF), Kerala State Council for Science, Technology and Environment (KSCTE), and National Institute of Technology (NIT), Calicut have acknowledged his idea.

4.1.3 Rubber smart tapper

Innovator: Prasad V N, Varakil House, Kalloorkad P.O, Muvattupuzha, Ernakulam

Prasad V N (44), A vocational school instructor, is on his way to developing an idea that might alleviate the rubber growers' labour shortage dilemma. He has a botany degree and also works as a rubber grower. When confronted with the dilemma of lacking labourers, he devised a remedy and developed this innovation.

This device is designed to autonomously tap rubber using solar energy and collect it in a chamber on a regular basis using its blade and can even function in low-light conditions. Due to a lack of time between the profession and proper knowledge in this field, the project is in the prototype stage and still under development. It is part of the Kerala Agricultural University's (KAU) incubation programme.

4.1.4 Rain guard for rubber

Innovator: Johny Varghese, Melaymannil House, Kuruvamuzhy PO, Erumely, Kottayam

Johny Varghese, a 49-year-old computer hardware engineer cum rubber farmer, pioneered an innovation that gives an alternative to the traditional method of guarding

rubber trees against the rain, which is more time-consuming, requires more labour, and produces large amounts of plastic waste during each season.

Instead of using virgin plastics that are only useful once, this ready-to-use invention comprises home-generated plastic trash that is easily recyclable. The innovation, which is now in its prototype stage, can bring down the cost of purchasing virgin plastic materials. This innovation can significantly reduce the production of plastic trash and save time because the belt is already pre-fixed.

The Kerala Agricultural University's (KAU) Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) startup programme awarded the concept an 8 lakh grant, and the startup provided many people the opportunity for self-employment in raw plastic processing.

4.1.5 Earth digger for farmers

Innovator: Antenitto P B, Puthupalliyil House, Thurakkal P.O, Manjeri, Malappuram

A farmer named Antenitto, who is 57 years old and has a background in mechanical engineering, invented a device that can be used to make pits for crops like bananas, rubber, coconut, etc.

The device was designed in response to the extreme labour scarcity he experienced while cultivating. This device has components such as a petrol engine, drill bit, spring system, and a modified auger which can be used to dig holes. The modified auger, along with the spring mechanism, does have a daily capacity of taking 500 pits and uses only 4 liters of fuel.

Such an innovation saves labour costs and time to a great extent. For many farmers, the wheel system's ability to transport the machine to any land is a godsend. The idea was given financial backing by Krishi Vigyan Kendra (KVK), Malapuram, and National Bank for Agriculture and Rural Development (NABARD) grant, etc., and was awarded the 2nd best rural innovation prize in 2014 by Kerala State Council for Science, Technology and Environment (KSCSTE) and going to be commercialized.

4.1.6 Hand-operated arecanut dehusker

Innovator: Yesudas V M, Vazhamplackal House, Vilangad P O, Kallachi, Kozhikkode

Yesudas, 68, a native of Vilangad, Kozhikode, with a high school education, developed a novel instrument for dehusking arecanuts. In five minutes, the new equipment can quickly break up one kilogram of dried arecanut. This iron-made equipment comes with a ten-year warranty and costs around four thousand rupees.

The innovation was developed mainly as a solution to the problem of labour shortage faced by the arecanut farmers. The machine is spring-operated and readily controlled by hand, thereby protecting the operator from typical injuries of arecanut peelers and is remarkable since it does not require electricity or anything else.

For this innovation, the innovator received the Kerala State Council for Science, Technology and Environment (KSCTE)- 'Best Innovator' Award and has been featured in events such as the Kerala Science Congress (KSC), the Krishi Yantra Mela, the National Innovation Foundation (NIF) innovator programme etc. The machine is now in its commercialization stage.

4.1.7 Intelligent coffee bean harvester

Innovator: Ajin Martin, Cherukaattor P.O, Panamaram, Wayanad

Ajin, 21, a life science graduate cum farmer, designed a unique form of coffee bean harvesting mechanism as a response to the region's long-term labour shortage among coffee producers. The device generates waves that separate the beans from the branches and allow them to be gathered later.

The machine's design may be tailored to the user's needs, and it can even be powered by electricity, a generator, or a battery pack. An automatic intelligent control system may be utilized to repeat its operation cycle. A clamping belt and changeable rubber padding hold the machine to the plant.

This high-efficiency machinery can harvest around one acre of a coffee plantation in 24 hours. The equipment can function without damaging plant tissues and significantly cut farmers' workload. This innovation was featured in Kerala State

Council for Science, Technology and Environment (KSCTE)-Rural Innovators Meet (RIM) 2021 and is under the prototype stage.

4.1.8 Smart latex collector

Innovator: Ajin Omanakuttan, Kizhukayil House, Nalukody P.O,Changanasseri, Kottayam

Ajin Omanakuttan, a 26-year-old farmer and technical officer with more than three years of industry experience, introduced an innovative solution to the ongoing challenges of rubber growers in the state. Latex is difficult to gather for rubber farmers since they must move from one rubber to another while collecting it in a bucket while carrying it around.

Ajin created a smart latex collector that is simple to use and can be utilized as a backpack for collecting latex in order to overcome these difficulties. It is simple to collect the rubber latex straight from the cup using this PVC container bag, which has two inlets and a long funnel. The device, in its minimum viable product stage, is portable, light, and simple for both left- and right-handers.

The Kerala Government provided funding via the Kerala Startup Mission for this ground-breaking concept, which has since been highlighted in programmes like Indian Science Congress Association (ISCA), Kerala Agricultural University Agri Business Incubator (KAU ABI), and National Innovation Foundation (NIF). The innovation is in the minimum viable product stage and in the midst of further development.

4.1.9 Polybag filling device

Innovator: Simon George, Palamoottil House, Karippal P.O, Perumpadavu, Kannur

Mr. Simon George, 62, a rubber farmer and nursery owner, created a device that eliminates the need for time-consuming and labour-intensive manual filling of poly bags. Currently, the polybags are filled by hand without using any device. As a result, the time required is lengthy, and thus the cost is high. Typically, one labourer can fill 125 poly bags of size 55 x 25 cm daily, whereas this device allows two labourers to fill 1000 bags daily.

Simon's poly bag filling device', which is now in its production stage, consists of a cone-shaped soil-spiller attached to the top of a G.I. pipe rod attached to the side of a table of proper proportions and a prism-shaped vessel for taking the soil to drop into the spiller. The funnel is attached to the galvanized iron pipe with a 1.25-inch diameter and a length of 26 inches in a slanting position that is fixed to a 15-inch square iron table with a height of 10 inches. The poly bag is opened and placed beneath the funnel. The potting mixture in the funnel falls directly into the poly bag, reducing wastage as in manual filling. It is portable and does not require power.

The device is displayed in the Farmers' Science Museum at Krishi Vigyan Kendra (KVK), Kannur.

4.1.10 Arecanut wonder climber

Innovator: Prakashan Thattaril, Nambiary House, Mayyanad P.O, Calicut

Prakashan Thattaril, 68-year-old, a successful arecanut farmer and retired sales tax officer, introduced the revolutionary wonder climber. The device is a manually operated arecanut plucker which the innovator designed in just three years, earning him the latest recognition and demonstrating his passion for farmer-friendly innovations.

This commercialized wonder climber is a one-of-a-kind device widely used to harvest arecanuts. The device climbs the tree by pulling the large rope of 10 mm thickness in one direction. The sharp blade slices the mature arecanut, held in place by a holder. The device begins to slide down to the ground by pulling another rope. The farmer can do all this from the ground without climbing the arecanut tree. The machine is portable, and depending on the height of the trees, an average of 12 to 20 trees per hour can be harvested.

In addition, Prakashan successfully developed improved models of his product, with the insecticide sprayer finding a good market among farmers. However, the technicalities of export and his lack of familiarity with the procedures discouraged him from giving it a shot. He is rewarded for his creativity with the State government's Innovators Award, Krishi Vigyan Kendra (KVK) Grassroots Innovation award, and grants from organizations such as the National Innovation Foundation (NIF), Indian Council of Agricultural Research (ICAR),.etc

4.1.11 Air cooler cum humidifier

Innovator: Sunil P P, Thulasi House, Mannampotta P O, Palakkad

Sunil (53), who worked as an AC technician in Dubai for 25 years, went home and began his next chapter in mushroom growing. The key issues confronting mushroom farmers nowadays are controlling the room temperature and air humidity.

As a technician, the innovator practically used his knowledge to remedy this situation. He created an air cooler cum humidifier that can serve as a permanent solution to the problem. Anyone can successfully cultivate mushrooms if this innovation is used in conjunction with a mist chamber within an enclosed shed.

The device is made by inserting three one-inch coir pads into the sides of a plastic container after removing its side. Pipes were installed above these pads to facilitate water flow. A tiny water pump was made to spray water into the pads. The steam from a pressure cooker was directed into the container kept in front of the exhaust fan via a bronze pipe.

The device helps maintain humidity and temperature while promoting air purification, and pest attacks can be significantly reduced.

The innovator has been awarded as the most innovative farmer in his region. The idea was featured in the Kerala State Council for Science, Technology and Environment (KSCTE) Rural Innovators Meet (RIM) 2021. The device is now in its production stage.

4.1.12 'Poultry Mitra'-The poultry raking machine

Innovator: Bibin David, Vettikuzhiyil House, Kannoth P O, Kodanchery, Kozhikkode

Bibin (41) brought up the issue of the poultry farmers' ongoing daily raking of litter on the poultry farm, which requires a lot of time, and the labour cost goes up for large-scale chicken farms. This issue is fixed by the litter raking device developed by Bibin.

The machine's ability to function efficiently on the sand and cement floors is its greatest benefit. The machine is designed in such a way that it just comes into contact with the litter and does no damage of any kind to the floor.

The machine has four wheels with a two-foot spacing between them and seven sharp blades, which makes it simple to operate. The blades may be changed to fit our needs and are simple enough for kids to use. It is environmentally beneficial in its functioning because it doesn't need any fuel. It has been reported that using this machine can significantly reduce the use of coir pith and flooring dust on the farm.

Raking can be done with the help of the equipment, which lessens the lingering aroma of ammonia gas created by chicken manure. Furthermore, it improved the quality of the manure. Farmers have even noted that chickens' weight has improved on the adopted farms. The concept was highlighted at the Kerala State Council for Science, Technology and Environment Rural Innovators Meet (KSCSTE-RIM) 2021 and received numerous honors.

4.1.13 Wooden Paddy Thresher

Innovator: Vijayan P P, Valad P O, Mananthavady, Wayanad

Vijayan (64), a farmer from Wayanad, has designed a paddy thresher machine for threshing about twelve bundles of paddy in just five minutes. The machine is manually controlled and doesn’t need fuel or electricity. Using this machine, he could thresh the paddy on his one-acre plot.

When the innovator realized that it was difficult to rent a thresher from the *Padasekharasamitis*, he eventually developed this device to ensure that a similar circumstance never arises again.

The thresher was constructed on a wooden board two meters wide and one meter long. The machine was made with a belt, iron pieces, and nails. The device is easily detachable into separate parts, which can be put back together once transported to a particular location. The machine is simple to operate and requires little effort. Vijayan claimed that his woodworking skills were beneficial to him in creating the machine. A

motor can also be used to drive the device. Vijayan presented this machine at the Rural Innovators Meet-2021, which is now in its minimum viable product stage.

4.1.14 Agro easy tapioca plucker

Innovator: Jose V V, Vallopillil House, Anjiri P O, Thodupuzha, Idukki

Jose (62), a farmer from Thodupuzha, created a concise and creative tapioca plucker tool that greatly increases productivity for tapioca farmers. Typically, harvesting tapioca is a labour-intensive task that requires a lot of manual labour, which results in significant time loss and labour wages. The device, called "Tapioca Plucker," is made to work like a plier, with two jaws and a support to keep it attached to the soil.

The jaws can come in touch and hold the stem, and with the help of the support, tapioca can be easily plucked out of the soil in no time and without damaging the tuber. The main challenge he faced in developing this machine was his lack of welding experience. The device, which is commercialized, can harvest about two bunches of tapioca at a time and can be used by anyone. It needs no maintenance or fuel and is environmentally friendly.

The key benefit of this tool is that it makes labour shortage issues simple to solve and saves money for farmers. It is now sold under the brand "Agro easy." The tool has been displayed at numerous exhibitions and the Rural Innovators Meet 2021.

4.1.15 Climbing gear for trees

Innovator: Murali P, Parackal House, Thrikadeeri P O, Ottapalam, Palakkad

Murali (38) came up with the idea of developing a tree-climbing device that can be utilized to climb all types of trees regardless of the weather conditions in a location. This innovation is frequently used overseas to easily and safely climb trees.

The traditional climbing technique used in our state has caused numerous accidents and injuries over time, and this machine was developed as a solution. Without compromising the material quality, the machine is made to be lightweight. The device is sharp with safety shoes and heels for safety. The customer can understand how to operate this climber with ease.

The climbing spike is more durable and economical to use. This has a polyester belt and is made of durable steel and plastic with MCR padding, making it more pleasant for the legs. It is more comfortable to use with a nylon lanyard of 3 meters (14 mm wide) with a gripper and a safety belt. The effort one puts into choosing the traditional way can be reduced here to a great extent. His concept has been displayed at various exhibitions and in the rural innovators meet. The device is also available on the Amazon online platform.

4.1.16 Coconut dehusker with gear

Innovator: Asharaf A, Alampara House, Kanjirakkadavu, Ottapalam, Palakkad

Asharaf (45) innovated with modified coconut husking equipment which has a greater advantage over the currently available market. There are many types, sizes, and prices to choose from. These include those that wrap up to a thousand coconuts per hour. But the main issue faced by farmers is shoulder pain after wrapping coconut. The health threat posed by this is not small. Asharaf has prepared a device that does not have this crisis for ages.

The difficulty for the farmers was caused by the fact that the lever attached to the tongue was pulled directly so that the entire effort required for wrapping came to the hands. Instead of the effort coming directly from the tongue to the hand, the new device uses gears. This was made possible by arranging a set of gears between the tongue and lever of the existing spade.

It also has the advantage that the effort is reduced by one-third compared to the existing device. He says that if this device is manufactured commercially, it can be used by the public at a far lower price. He hopes the device will get a huge following as it can wrap coconuts effortlessly. The machine is currently in its minimum viable product stage and is expected to set a revolution soon.

4.1.17 Pepper Thresher

Innovator: Ravi P K, Palathumthalackal House, Upputhodu P O, Charalanganam, Idukki

Ravi (55), an Idukki farmer, invented a pepper thresher that can thresh pepper berries mechanically and manually. Pepper is often threshed by hand, which is a labourious and time-consuming task performed usually by women. The berries may be damaged during the threshing process, and the threshing percentage is also poor. These challenges prompted Ravi to devise a solution and design a machine.

The thresher comprises a feeding hopper made of iron sheet, a rotating wire-loop type threshing drum, and a concave metal sheet with a perforated bottom, all mounted on the main frame.

Ravi's machine can run on electricity and operate manually when necessary. It can also be used to thresh paddy by changing the machine's leaf. The 'Aurora,' as the machine has been named, is now commercialized and has a threshing capability of 300 kg/hr to 600 kg/hr in electric mode.

The Spices Board (Ministry of Commerce and Industry, Government of India) recognized his innovation and incorporated it into the Spices Board's subsidy plan. The innovator was recognized at the National Innovation Foundation's (NIF) third award function and was sponsored by the NIF Micro Venture Innovation Fund (MVIF) programme. This innovation received various state and national recognitions.

4.1.18 Hand-Operated Arecanut Peeler

Innovator: Shaju P S, Puthiyakunnel House, Chathangottunada P O, Kavilumpara Calicut

Shaju (55), an arecanut farmer from Calicut, devised a tool to make peeling arecanut considerably easier. The toughness in the operation of dehusking instruments and a lack of labourers for various operations linked with arecanut processing are increasingly common in the field and cost time and energy. The unique tool built by Shaju can easily peel out many arecanut quickly.

The machine perforates the outer region of the arecanut and can remove the outer cover, separating the nuts. The older version of the machine was based on the spring mechanism, which was found to be less efficient over time owing to its breaking, and the latest version of the machine, which is now commercialized, has worked out this issue and is recognized as a blessing amongst arecanut farmers.

The mechanical skills of the innovator have led him to make advancements in several other fields too, making relevant contributions to society. Arecanut peelers are presently marketed through a partnership with the Regional Agro-Industrial Development Co-operative of Kerala Ltd (RAIDCO) and were assisted by National Bank for Agriculture and Rural Development (NABARD). This equipment has been displayed at various exhibitions and the Krishiyantra mela 2012, which was held in Puttur, Karnataka.

4.1.19 Nutmeg Desheller

Innovator: Sachidanandan V R, Veliyath House, Aduvassery P O, Ernakulam

Sachidanandan, 72, is from where the nutmeg plant, *Myristica fragrans*, is widely grown. Although decorticated nutmeg (kernel) demands a high market price, cultivators typically sell nutmeg without decortication because it is labourious and time-consuming.

Nutmeg is typically decorated mechanically or manually using a hand tool for cracking. Given the cost, time, and effort involved in decorticating nutmeg, which is roughly twice as expensive as raw nutmeg, it becomes uneconomical. This inspired him to develop a machine that would make the process quick and simple.

The commercialized machine is functionally efficient and decorticated over 95% of adequately dried nutmeg in a single pass. It consists of a hopper, a striking drum, a rotating disc with "S-shaped" baffles, a motor, an output chute, an outer casing, and a stand. The efficiency is about 90%, and it is the only one on the market for decorticating nutmeg. Nutmegs that weren't decorticated during the first feed are then fed again with others for decorticating. Consequently, farmers can increase their income from nutmeg production by 40 to 50 percent.

Sachidanandan is a very down-to-earth man who wanted to use his knowledge, experience, and creativity to assist farmers and common people. His innovation has received numerous national awards and was awarded the National Innovation Foundation (NIF) Grassroots Innovation Award in 2015.

4.1.20 Arrowroot powdering machine

Innovator: A T Thomas, Edayal, Melukavumattom, Kottayam

Thomas (68), an arrowroot farmer from the Kottayam district, devised a motorized machine for powdering arrowroot. The traditional method for making arrowroot powder involves rubbing the rhizome by hand over a perforated sheet. The drawbacks were the labourious procedure and the potential for injury to the hand if focus faltered. To overcome these challenges, he created the prototype of a machine 20 years ago. Three years later, he made significant improvements. The remastered edition of the innovation was created ten years ago.

The operation of the device is straightforward: a 1 HP motor drives a 6-inch spinning wooden shaft coated in a perforated metal sheet with a belt. A feeding chamber provides direct access to the roller from the top, and the distance between the shaft and support is adjustable. Arrowroots move to the area between the spinning shaft and support as soon as the motor is turned on and scraped there. The paste spills onto a tray that is kept slanted in the center of the apparatus. The paste transforms into a clear arrowroot solution after seven cleanings.

Using this machine that can scrape 100 kg of root in 20 minutes, the powder is filtered out after settlement and used as a dietary supplement. National Innovation Foundation (NIF) gave the innovator a consolation award in its 1st National Competition for Grassroots Innovations and Traditional Knowledge in 2001.

4.1.21 Automatic rubber tapping machine

Innovator: Sreerag Vinoth, Sreeragam House, Kondazhi P O, Thrissur

Sreerag (22), a young, smart, and imaginative rubber farmer and an engineering student, has come up with a creative solution to the hardships the state's rubber farmers are experiencing. Farmers have always had a difficult task when using the traditional rubber tapping method, and using a knife can occasionally cause harm, especially if the farmer is unskilled.

The idea proposed by Sreerag describes a method in which rubber trees are tapped by drone-like apparatus that travels from one rubber tree to another. When we

connect the rubber trees with a mechanism like a string and the rubber trees are planted row by row, which facilitates this operation. The process can also be executed using a timer, which uses the minimum amount of labour possible.

Since this ideation is still in its prototype stage, several hurdles stand in the way, such as the thickness variation of the tree, the age of the trees, etc. The idea has received additional support from Kerala Agricultural University's Entrepreneurship Orientation programme.

4.1.22 Refined pepper thresher

Innovator: Gopalakrishna Sharma, Saravu House, Padre P O, Perla, Kasargod

Gopalakrishna Sharma (60), an ingenious farmer from Kasargod, has created a refined version of a pepper thrashing machine, allowing farmers to complete threshing tasks in a timely way when the pepper market is frequently unstable. A modified version of the present machinery, in which pepper wines frequently get stopped during the threshing process, has been developed by Mr. Sharma, renowned for using intensive agricultural techniques. This affects the very efficacy of the equipment.

The machine is powered by a half-HP, 1440 rpm electric motor. The berries that have been removed from the stems fall through the holes onto a fixed plate and are gathered in a receptacle kept at the base of the machine. The opposite end of the apparatus has an opening door that can be used to gather the stalk after threshing. A rubber sheet collects the threshed pepper at the base of the fixed plate, which directs it to a receptacle housed at the machine's base.

The machine, which is in its commercialization stage, can thresh 250 kg of pepper granules per hour, whereas a person engaged in human threshing could anticipate having an average of 100 kg of pepper per day. Given the labour shortage among pepper growers, the machine looks like a suitable replacement. The machine has been awarded by institutions like Krishi Vigyan Kendra (KVK) Kasargod, National Bank for Agriculture and Rural Development (NABARD), National Innovation Foundation (NIF)..etc.

4.1.23 Black pepper plucking tool

Innovator: Pratheesh C, Chakkamthodi House, Alanellur, Palakkad

Pratheesh (38) created ingenious black pepper plucking equipment with a triangular cup beneath the blades to hold the chopped pepper bunch. He is a mechanic and has a workshop for manufacturing grills, gates, etc. After studying till class ten, he undertook training at an Industrial Training Centre (ITC). After that, he met another innovator and started working together on several innovations, including stone-cutting machines and sand-separating machines. Later he built a workshop for the manufacture of some of these innovations. However, he found it tough to promote them successfully.

To make the pepper plucking tool, a farmer from his village approached him and sought a solution. It consisted of a two feet long PVC pipe attached to a triangular cup with teeth on the upper side of the cup. The teeth of the plucker cut the stalk of the pepper, and the pepper gets collected in the cup below. The length of the nipper is adjustable by attaching a PVC or GI pipe. While nippers are available for fruits, this is a simple modification to fit pepper plucking. He was awarded for his innovation in the 7th National Grassroots Innovation Awards 2013.

4.1.24 Coconut dehusking machine

Innovator: Abhilash Emmanuel, Kannivayal P O, Munayamkunnu, Kasargod

Abhilash Emmanuel (43) devised and built a power-operated coconut dehusking machine to assist coconut producers who have difficulty finding labour to shuck coconuts. The device developed can wrap up to 1200 coconuts every hour. After working arduously for three and a half years, he was able to construct the machine.

A 7 HP diesel engine powers the machine. One liter of diesel can power the machine for four hours. This dehusking consists of two horizontal rollers with a series of sharp tools that would shear the husk from a coconut while rolling against each other. Shear force is necessary for dehusking of mature green coconut and dried brown coconut. The sheer power required is higher for mature green coconut than dried coconut.

The coconut dehusking machine is composed of a cutter with a belt drive. Performances test analysis revealed that the machine de-shelled the fruits without the nut breaking. The loading and unloading are done manually. Compared to the traditional coconut dehusking machine, the output rate rises this way. The machine is in its minimum viable product stage.

When the innovator couldn't find somebody to wrap his coconuts, he designed the machine. A lot of people are coming over to buy it. Since the machine is installed to a connector, moving it anyplace is simple.

4.1.25 Automated rubber tapper

Innovator: Joseph P V, Puthupparambil House, Kaliya Road P O, Chelakkara, Thrissur

Joseph (72) worked as an electronics technician in Coimbatore. Fifteen years ago, this farmer started working in agriculture after quitting his job to pursue his passion. The primary crop grown on the three acres of land he owned was rubber. Finding proper technology that may assist in tapping rubber was always challenging for the farmers.

After then, it required nine years of experimental investigation to develop a wholly accurate model. The rubber tapper, which is now commercialized, is 900 grams in weight, and the main parts include a motor to drive the machine, a gearbox, a mechanical sensor to stop further penetration into the wood, a level controller to control cutting thickness, a balancing wheel, a three-petal cutting blade, a secondary cutter to cut the front and back portion, a handle to hold the machine so that it can tap both sides of the rubber, a power switch, and a power supply battery.

Auto taper cuts the strip to a specific thickness without using any force by setting the machine on top of the rubber-cut strip and turning on the switch. The machine has to be moved along the belt by the hands. While cutting, the belt is supported by the weight of the machine. Three circularly rotating blades cut the rubber. The wood is cut to a thickness of 1.5 mm. The auto-taper machine also has a mechanism for keeping the blades stationary for long periods without damaging the wood. Depending on the type

of tree, 400 to 550 trees can be tapped once after the battery is charged. The rubber tree's tapping life may be quadrupled by enabling bump-free tapping with an auto taper.

In the Rubber Board Tapping Machine Competition, the Auto Tapper was chosen as one of the top models. In 2018, Value Addition for Income Generation in Agriculture (VAIGA) international fest showcased the innovation.

4.1.26 Cardamom washing machine

Innovator: Thomas N J, Nirappel House,Puliyanamala, Idukki

N.J. Thomas (67), a small farmer from Puliyanmala in Kerala's Idukki District, designed a cardamom washing machine that can remove mud from cardamom in 30 seconds and then change the water in the next 30 seconds. Dust and extraneous objects are removed from the collected capsules using a cardamom washing machine. Upto 100 kilograms of cardamom, can be dried. The fact that just 25 liters of water must be used for washing is also unique. With this equipment, 500 kg of cardamom may be cleaned in the time it would normally take two people to wash 100 kg. This device, which was created in 2011, is now widely utilized in the cardamom industry.

Since everything was done by hand at the time, he ran into issues with washing and polishing the cardamom. So, to deal with this monotony, he came up with an innovative thought that enabled him to lay the foundation for creativity.

After learning how the machine operated, many private industries tried to produce similar machines. However, he is happy that his innovation has reached more farmers. Thomas used the basic design of the cardamom polish machine to create this commercially available cardamom washing machine. He also got support from Indian Cardamom Research Institute (ICRI), the Spices Board, and the Peerumedu Development Society and received the Indian Agricultural Research Institute (IARI) ‘Innovative Farmer’ award for the machine.

4.1.27 Paddy cleaner

Innovator: Sadasivan M, Kalyanapettakkalam, Kannimari P O, Palakkad

Sadasivan (45), from Palakkad, built a unique type of paddy cleaner that addresses all of the flaws associated with using a winnower to clean paddy. The traditional method of employing a winnower demands more labour. Paddy must be loaded into the winnower each time.

However, in this case, the paddy is mechanically sucked in by the machine as it is piled up on the ground. The paddy enters the machine's shaker's net, located within. The leftover material is then transferred into the larger net after removing the soil fragments and weeds. The clods, straws, and stones that are present in the remaining section separate at this point. Paddy and husk will both fall simultaneously to the blower positioned on the bottom. The blower removes the thin husk, and the channel of the shaker releases the cleaned rice. These grains of rice may be quickly and easily gathered by placing a bag in front of the mouth.

The equipment cleans 1.5 tonnes of paddy in an hour and runs on electricity. The device comprises a blower, a paddy-sucking screw, a conveyor pipe, and a moveable shaker. It contains two 1.5 horsepower single-phase and 0.5 horsepower motors. Depending on the moisture content present in the paddy, a control switch may be used to alter the air-blowing force. The machine's isolator and MCB connection prevent unintended danger from happening and can be transferred to any location as desired. The device, which is in its minimum viable product stage, weighs roughly 425 kilograms and can fill rice bags with 4000–5000 kg of rice in an hour. The concept was highlighted at the Kerala State Council for Science, Technology and Environment (KSCTE) Rural Innovators Meet 2021.

4.1.28 Automatic solar dryer

Innovator: P V Jose, Pullan House,Chalakkudy,Thrissur

Jose, who is 83, has been involved in farming for more than 55 years. Being a nutmeg farmer, the innovator encountered numerous challenges in properly drying the nutmeg aril without any environmental contamination. This led to a thought of an innovation that could address this issue. The final result is an automatic solar dryer.

The equipment, which is now in its production stage, uses solar energy to speed up drying, and the glass covering can shield items from birds and insects. Although the

innovator is researching a fully automatic electric dryer with the newest technology, financial limitations remain a significant concern. Shri. Jose has received recognition as the most innovative farmer in the area by the Krishi bhavan.

4.1.29 Multipurpose motorized wheelbarrow;

Innovator: Manu Joseph, Kaayalil House, Nettithozhu P.O, Kochara, Idukki

Manu Joseph, a 38-year-old Idukki native, invented an engine that assists farmers in tilling the soil, carrying cargo, and applying fertilizer. From tilling the soil to transporting the crop from the fields to the roadside, the entire procedure is challenging for farmers to do alone. He tried to create a machine that would lessen the amount of effort they had to put in. Manu proceeded by sketching a basic design of the machine and listing the materials required to construct it.

Even though he had a rough idea of how he wanted to build the machine, he struggled to arrange funds to purchase the necessary materials. He often had to restart from scratch while working on the machine owing to engine problems. He kept pushing himself, and it took him seven months to do the project, and it is now ready for commercialization. This multipurpose motorized wheelbarrow is a hand-operated machine that runs for more than two hours on one litre of petrol and features a 7HP motor engine.

4.1.30 Modified earth auger for digging pits

Innovator: Sajay Rajan, Thottapallil House, Amarabalam P O, Malappuram

The idea is to simplify the method of operation of the earth auger. The biggest problem with earth auger is its vibration. When the auger operates on a hard surface, a good part of the vibration passes to the operator's shoulder. It causes severe pain and discomfort. Further, when the soil is wet, the machine can become immovable. So even though the auger is a highly useful machine, it has many inherent deficiencies. Hence, the proposed innovation is to make the auger more user-friendly with a gear reduction mechanism.

Most augers operate at high speed. However, to bring maximum soil up from the depth, there should be control on the rotating speed. Hence, he introduced an

appropriate gear system to this. Further, the capacity of the engine also requires special consideration. It becomes crucial when making standard pits of 50 cm in depth and diameter. The Introduction of the shock-absorbing mechanism is yet another intervention to be carried out. The device is now in the prototype stage and will soon be commercialized for a revolutionary change in the auger design and production.

4.2 Reason for development of the innovations

According to Table 4.1, From the listed innovations, the reason for the evolution of most innovations (50 %) was due to the problem faced by peers, followed by the problem faced by self (30 %). About 13.33 per cent of innovations were made to innovate something new, while 6.67 per cent of innovations were made to satisfy the service requirement of the customers.

Table 4.1 Distribution of innovations according to the reason for innovation development

Sl. No.	Categories	Frequency(n=30)	Percentage
1	To solve the problem faced by self	9	30.00
2	To innovate something new	4	13.33
3	To solve problems faced by peers	15	50.00
4	To satisfy the service requirement of customers	2	6.67
Total		**30**	**100**

The distribution of innovations based on the reasons behind their development has been shown in Figure 4.1

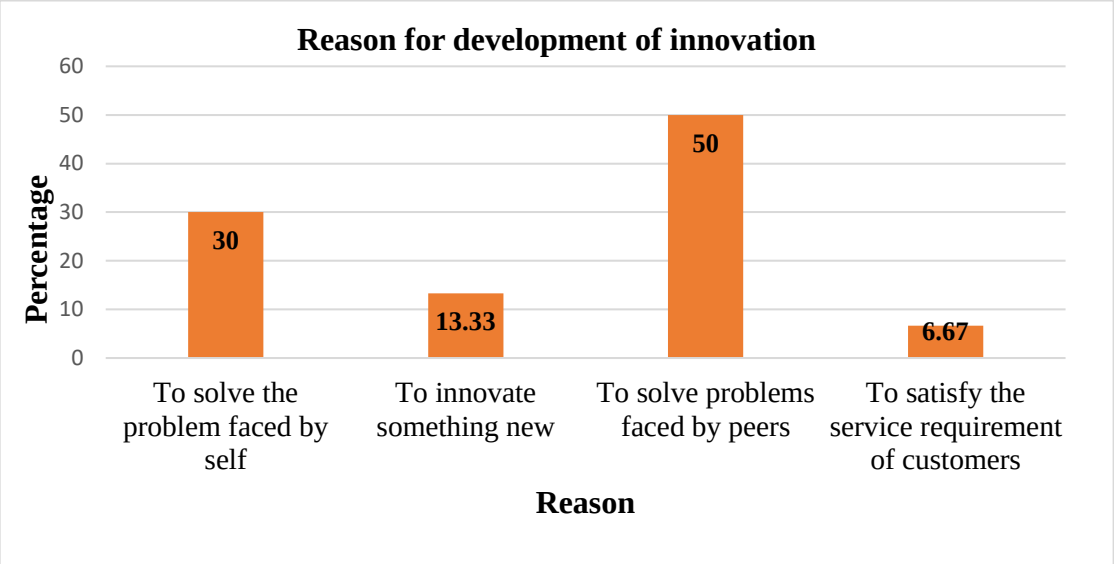


Fig. 4.1 Distribution of innovations according to the reason behind innovation development

4.3 Time taken for innovation development

The time taken by the farmer innovator for the development of his innovation was calculated, and the results are given in table 4.2. The results showed that more than half (66.67%) of the innovations had taken two to seven years for their current stage of development. While 23.33 per cent of the innovations had taken more than seven years and 10 per cent of these innovations had taken less than two years to develop.

Table 4.2 Distribution of innovations according to the time taken for innovation development

Sl. No	Categories	Frequency(n=30)	Percentage
1	Less than two years	3	10.00
2	Between two to seven years	20	66.67
3	More than seven years	7	23.33
Total		**30**	**100**

The distribution of innovations based on their time taken has been shown in Figure 4.2. The reasons behind the different time periods taken for development could be financial constraints, untimely support, lack of material availability, pandemic..etc

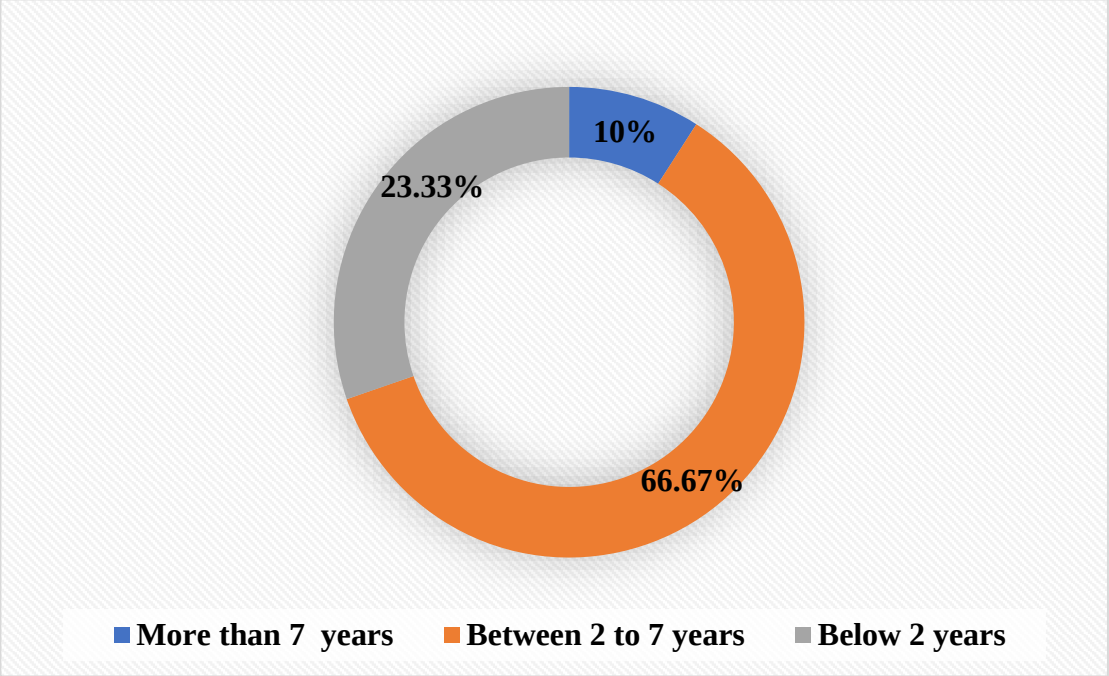


Fig. 4.2 Distribution of innovations according to the time taken

4.4 Stages of innovation development

The results from Table 4.3 shows that 63.33 per cent of the innovations had reached the commercialization stage, while 16.67 per cent of innovations reached only upto the minimum viable product stage. The innovations which came upto the prototype and production stages were only 10 per cent each.

Table 4.3 Distribution of innovations according to the stages of innovation development

Sl. No.	Categories	Frequency (n=30)	Percentage
1	Upto prototype stage	3	10.00
2	Upto minimum viable product stage	5	16.67
3	Upto production stage	3	10.00
4	Upto commercialization stage	19	63.33
Total		**30**	**100**

The innovations based upon their current stage of development show that most of the listed innovations are now capable of entering the commercialization stage while a few are still struggling to reach the commercialization stage. This is shown in Figure 4.3

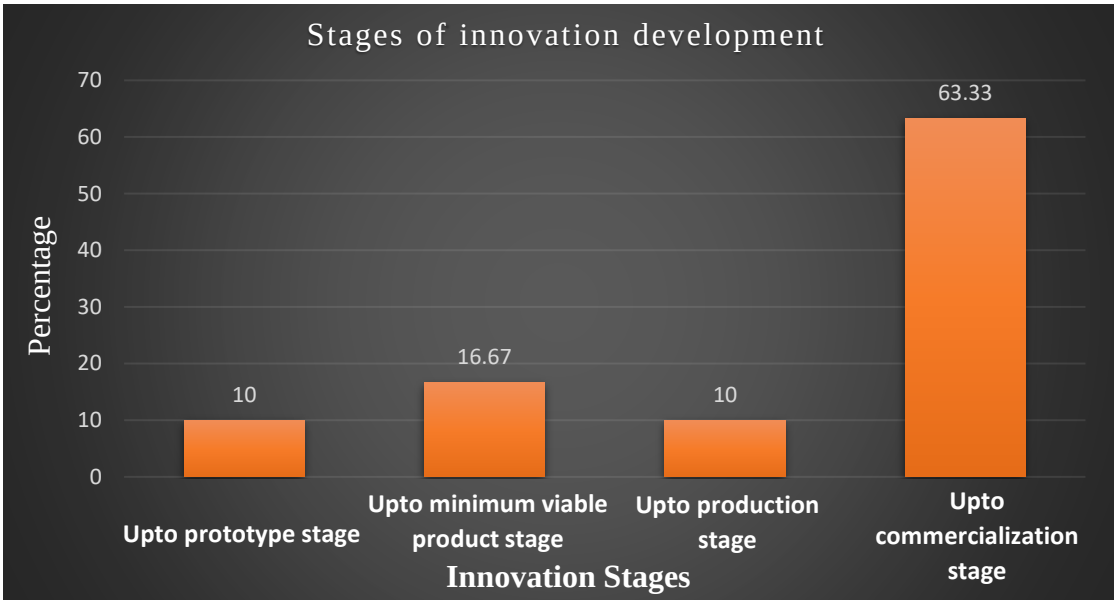


Fig. 4.3 Distribution of innovations according to the stages of innovation development

4.4 Profile of farmer innovators

The investigator could interpret the data if he or she clearly understood the respondents' socioeconomic and psychological characteristics. Data were collected from 30 farmer innovators from the field of agricultural machinery. Fifteen independent variables representing farmer profile characteristics were selected and included in the study. The results of data analysis on the profile characteristics are given below:

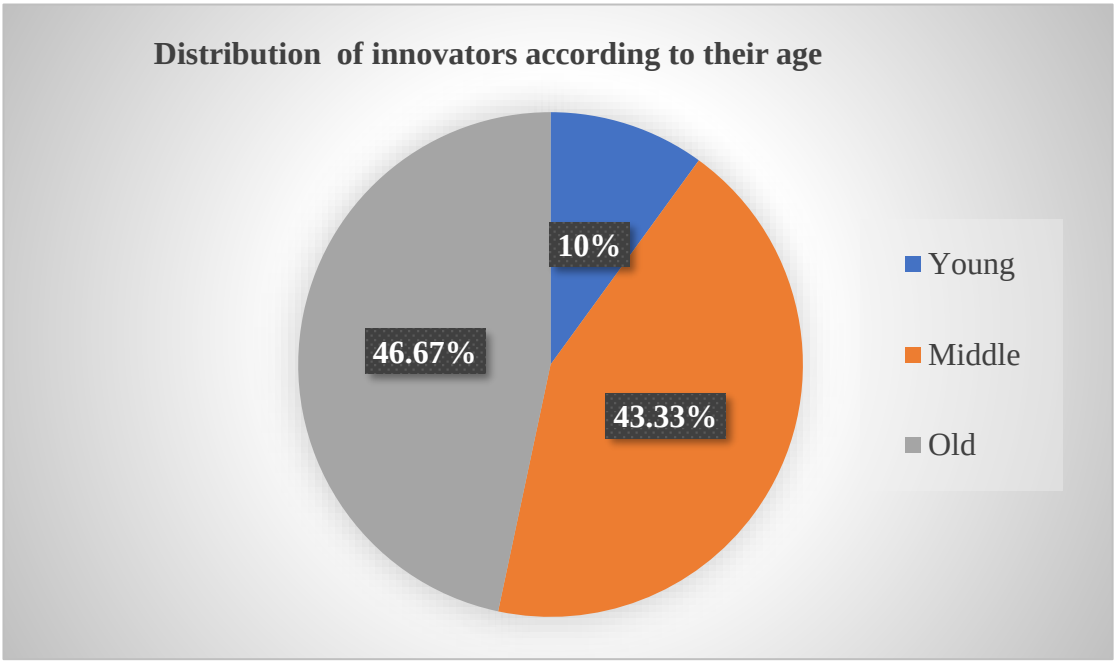
4.4.1 Age of the innovators

According to Table 4.4, most farmer innovators (46.67 %) belong to the old age category, while 43.33 per cent belong to the middle age category, and 10 per cent belong to the young age category.

Table 4.4 Distribution of farmer innovators according to their age

Sl No	Categories	Frequency(n=30)	Percentage
1	Young (upto 35 years)	3	10.00
2	Middle (36 to 51 years)	13	43.33
3	Old (Above 51 years)	14	46.67
Total		**30**	**100**

The old and middle-aged farmers have more experience and encounter many field problems. This makes them try innovative ways to solve problems. This finding is supported by the findings of Gulkari (2014) and Borate (2015). The distribution of



innovators according to their age is shown below in Figure 4.4

Fig. 4.4 Distribution of innovators according to their age

4.4.2 Educational status of farmer innovators

The data in Table 4.5 shows that the majority of the respondents, viz, 40 per cent had either graduation or diploma or ITI as the educational qualification, followed by 30 per cent of the innovators, having high school and higher secondary level of education

each. The probable reason for a fair level of education among the farmers might be explained based on higher literacy levels in Kerala. The results are shown in Figure 4.5

Table 4.5 Distribution of farmer innovators according to their education level

Sl No	Categories	Frequency(n=30)	Percentage
1	High school	9	30.00
2	Higher Secondary	9	30.00
3	Graduation/Diploma/ITI	12	40.00
Total		**30**	**100**

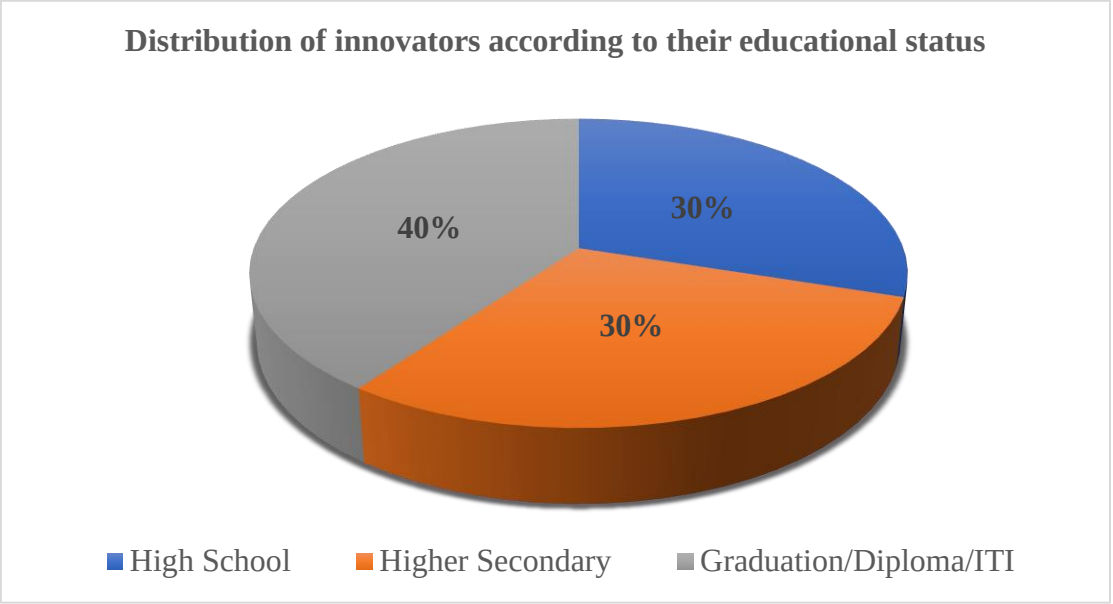


Fig. 4.5 Distribution of innovators according to their educational status

4.4.3 Farming experience of innovators

According to Table 4.6 below, the majority of respondents, around 63.33 per cent, have a low level of farming experience. In comparison, 26.67 per cent of innovators have medium farming experience. Only a few innovators have a high level of farming experience (10 %).The average farming experience of the farmer innovators is 24.2 years. Similiar results were obtained from the study conducted by Kishor (2010). The data is depicted in Figure 4.6. The most likely reason for this is that most farmers goes for an innovation only after having a stable income source other than farming.

Table 4.6 Distribution of farmer innovators according to their farming experience

Sl No	Categories	Frequency(n=30)	Percentage
1	Low experience	19	63.33
2	Medium experience	8	26.67
3	High experience	3	10.00
Total		**30**	**100**
Mean-24.2			**S.D-20.12**

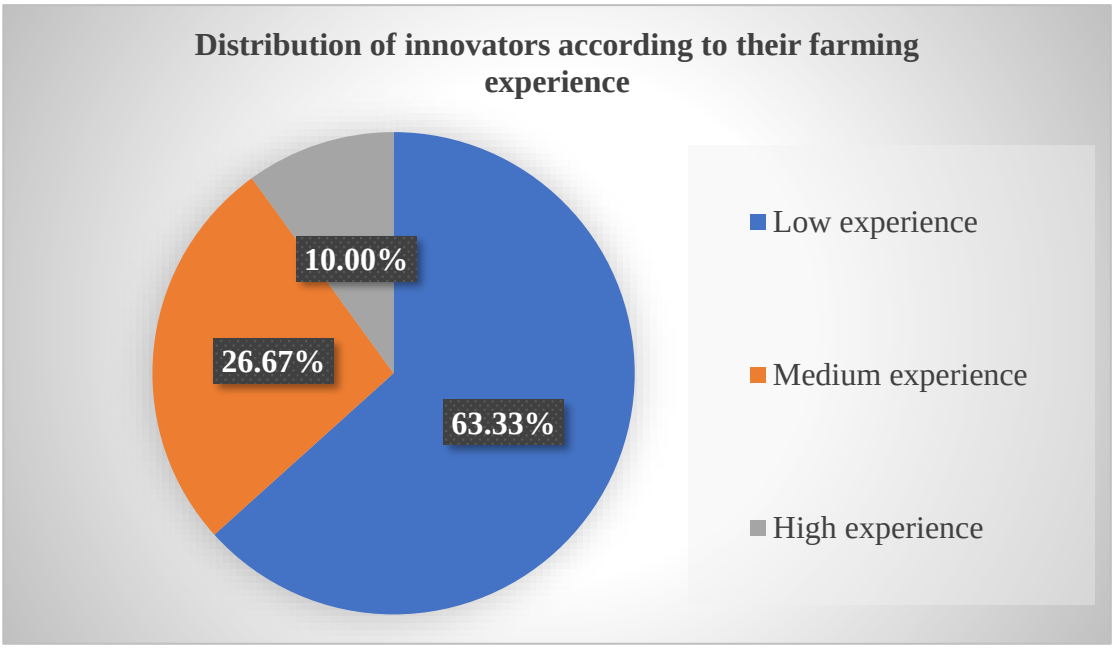


Fig. 4.6 Distribution of innovators according to their farming experience

4.4.4 Industrial experience of innovators

From Table 4.7 and Figure 4.7, it is clear that 43.33 per cent of the innovators had low industrial experience, followed by medium industrial experience (36.67 %). Only 20 per cent of the farmers exhibited a high industry experience. The average industrial experience of the farmer innovators is 8.23 years. This could be the case since most farmers have pursued careers and degrees unrelated to those in manufacturing,

equipment, or other engineering-related fields and have had no relation with the industrial sector for a long.

Table 4.7 Distribution of farmer innovators according to their industrial experience

Sl No	Categories	Frequency(n=30)	Percentage
1	Low experience	13	43.33
2	Medium experience	11	36.67
3	High experience	6	20
Total		**30**	**100**
Mean-8.23			**S.D-10.25**

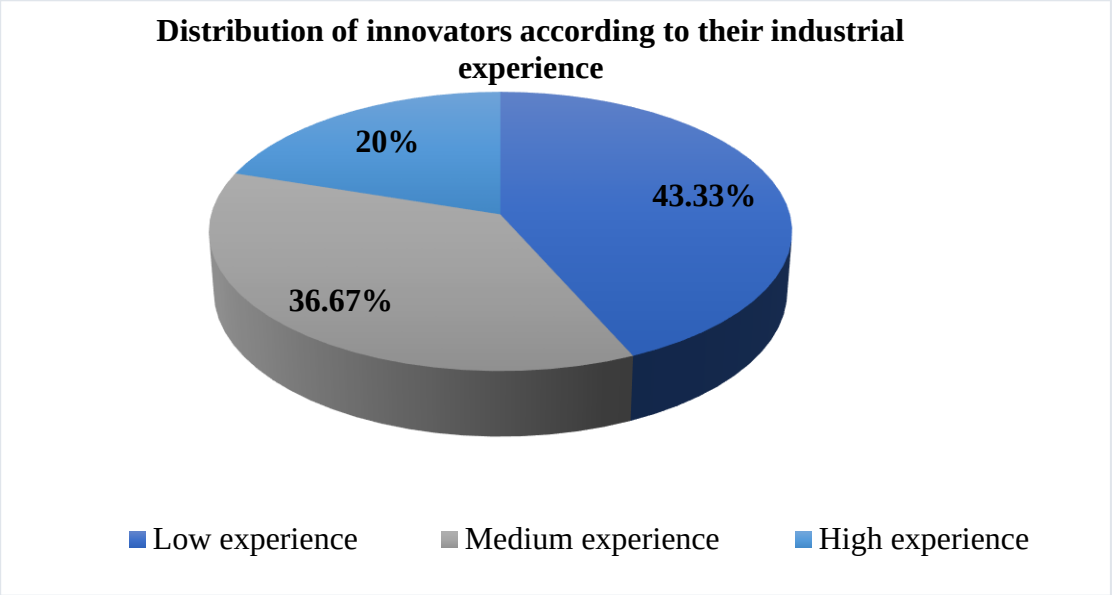


Fig. 4.7 Distribution of innovators according to their industrial experience

4.4.5 Annual income

The results in table 4.8 show that more than half of the farmer innovators (56.67 %) are having annual income in the range of 2 lakhs to 5 lakhs, followed by 40 per cent with an annual income of more than 5 lakh, and only one farmer (3.33 %) has an annual income below 2 lakh. These results show that most of the farmer innovators make only a moderate level of earning. The results are represented in Figure 4.8

Table 4.8 Distribution of farmer innovators according to their annual income

Sl No	Categories	Frequency(n=30)	Percentage
1	Low (Less than Rs. 2,00,000)	1	3.33
2	Medium (Rs. 2,00,000 to 5,00,000)	17	56.67
3	High(More than Rs. 5,00,000)	12	40
Total		**30**	**100**

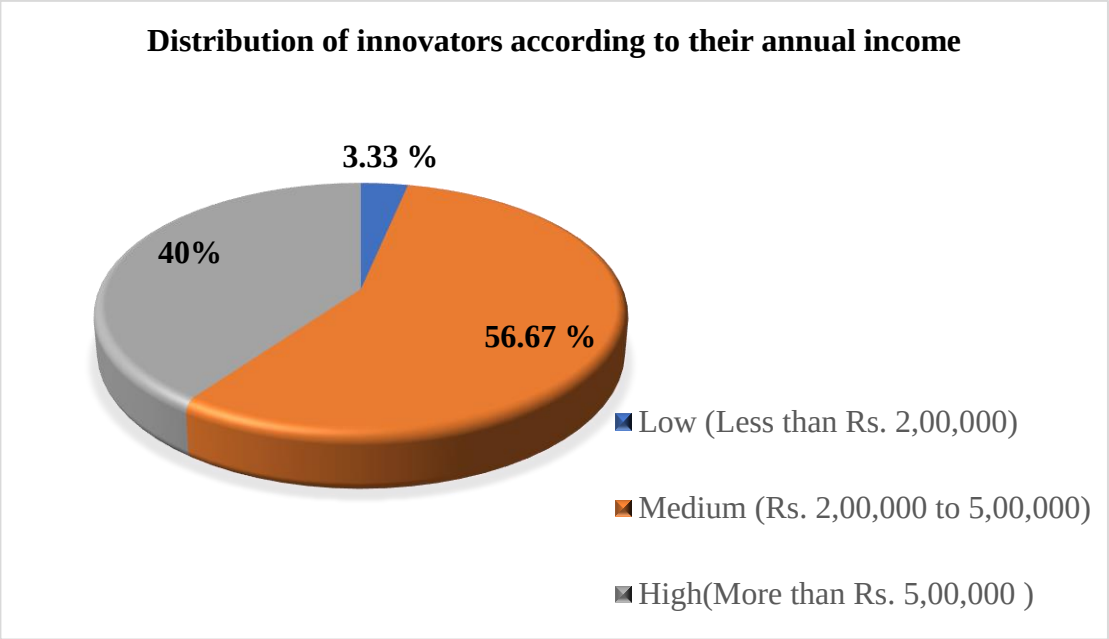


Fig. 4.8 Distribution of innovators according to their annual income

4.4.6 Occupational status of the farmer innovators

The given Table 4.9 depicts that most of the farmers (33.33 %) have farming along with labour and 30 per cent have only farming, 23.33 per cent with farming and service as their occupation, and 13.33 per cent earn with farming along with other business. This may be because most of the farmers think that farming only cannot provide a source of income for their livelihood. The distribution of innovators according to their occupational status is shown in Figure 4.9.

Table 4.9 Distribution of farmer innovators according to their occupational status

Sl No	Categories	Frequency(n=30)	Percentage
1	Only farming	9	30.00
2	Farming+labour	10	33.33
3	Farming+service	7	23.33
4	Farming+business	4	13.33
Total		**30**	**100**

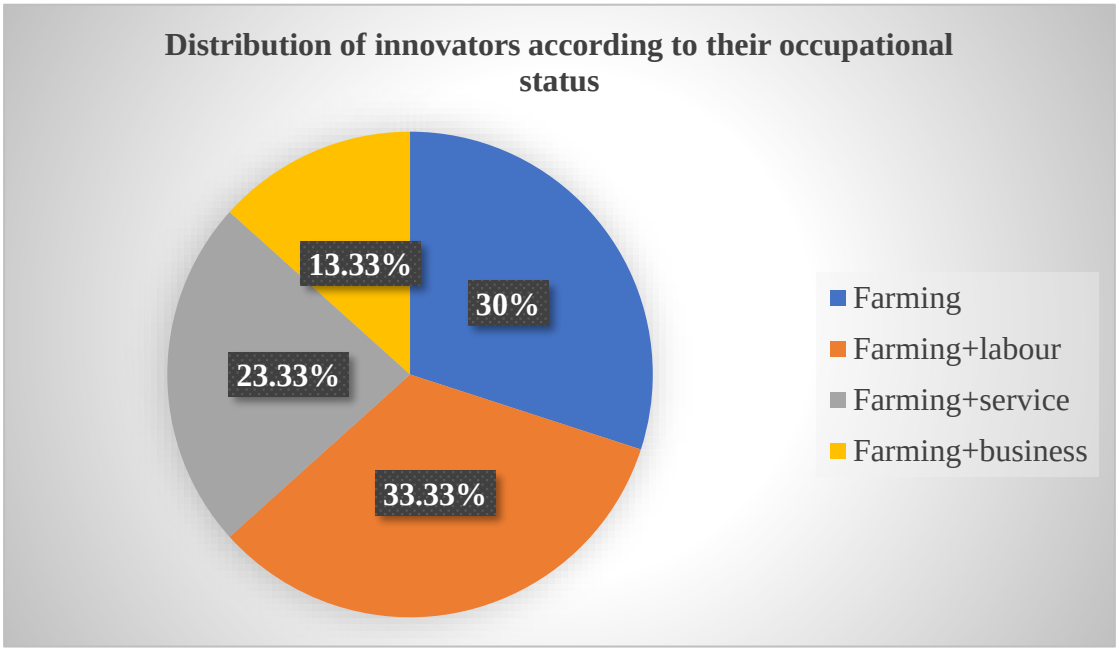


Fig. 4.9 Distribution of innovators according to their occupational status

4.4.7 Innovativeness of the farmer innovators

From Table 4.10 given below and Figure 4.10, it is clear that the majority of the farmers, i.e., 56.67 per cent, had medium innovativeness, while 26.67 per cent and 16.67 per cent of innovators showed low and high ranges of innovativeness, respectively.

Table 4.10 Distribution of farmer innovators according to their innovativeness

Sl No	Categories	Frequency(n=30)	Percentage
1	Low innovativeness	8	26.66
2	Medium innovativeness	17	56.67
3	High innovativeness	5	16.67
Total		**30**	**100**
Mean-18.67			**S.D-2.62**

The probable reason for this is that most farmers are concerned about trying out new ideas and their further development and support. These results confront with that reported by Bhagyalakshmi *et al.* (2003)

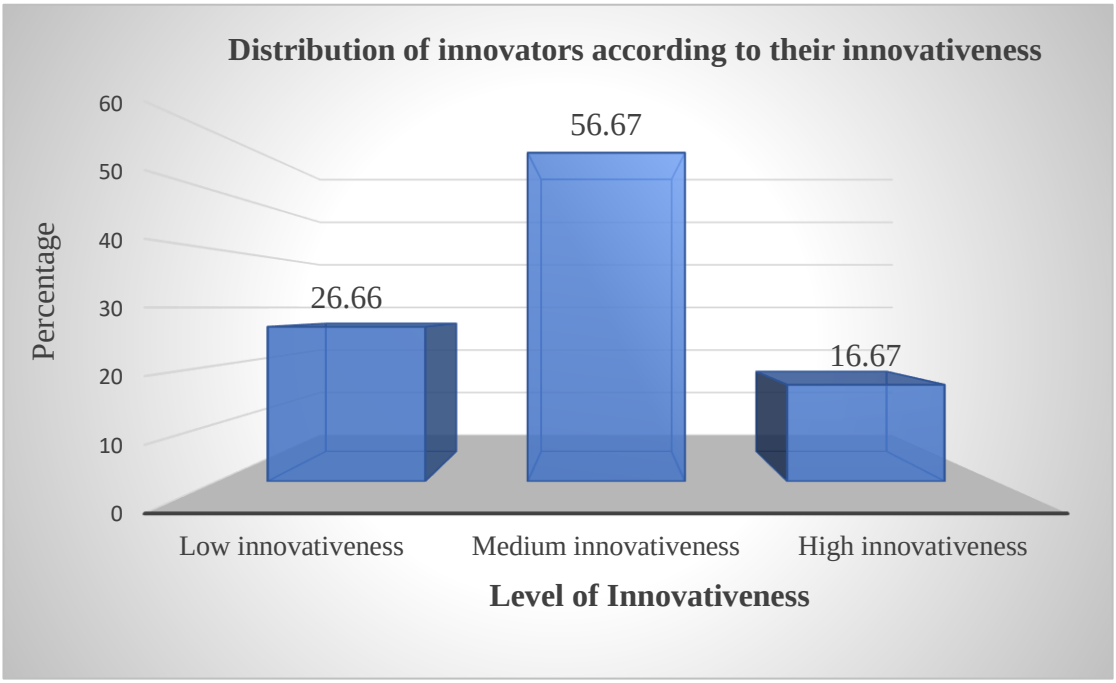


Figure 4.10 Distribution of innovators according to their innovativeness

4.4.8 Information seeking behavior of the farmer innovators

According to Table 4.11, 36.67 per cent used a combination of formal, informal, and mass media as their knowledge sources, and 26.67 per cent of the innovators relied on formal sources and informal sources. About 16.67 per cent of innovators relied only on formal sources, and 13.33 per cent of innovators solely on informal sources. Only a small percentage (6.67 %) of innovators depended on both formal and mass media

simultaneously. This is because farmers rely on information sources based on their accessibility. The distribution is depicted in Figure 4.11

Table 4.11 Distribution of farmer innovators according to their information seeking behavior

Sl No	Categories	Frequency(n=30)	Percentage
1	Formal sources	5	16.67
2	Informal sources	4	13.33
3	Formal+informal+mass media	11	36.67
4	Formal+informal	8	26.66
5	Formal+mass media	2	6.67
Total		**30**	**100**
Mean-11.5			**S.D-2.54**

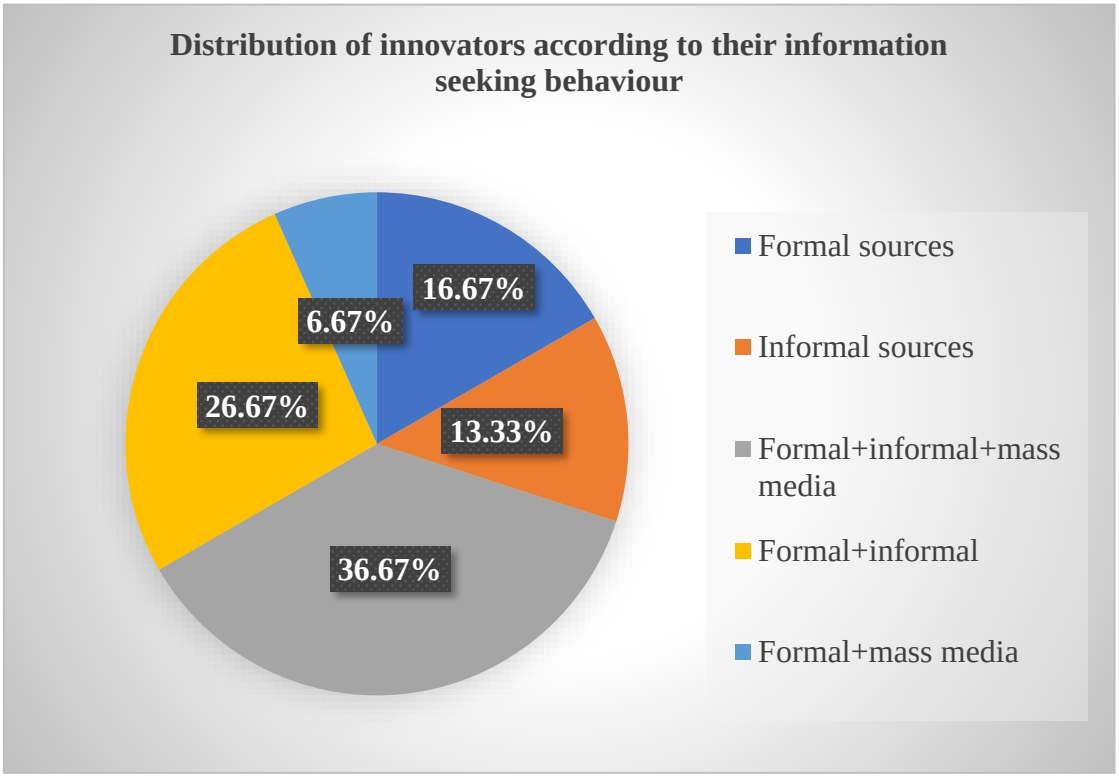


Fig. 4.11 Distribution of innovators according to their information seeking behavior

4.4.9 Scientific orientation of the farmer innovators

From the results of Table 4.12 and Figure 4.12, it is clear that innovators with medium scientific orientation comprise the majority (76.67 %), followed by 13.33 per cent having low scientific orientation and 10 per cent with high scientific orientation. This could be because most innovators are trying their best to gain maximum knowledge and awareness associated with their area of interest. The results are on par with that obtained by Basanayak (2012).

Table 4.12 Distribution of farmer innovators according to their scientific orientation

Sl No	Categories	Frequency(n=30)	Percentage
1	Low scientific orientation	4	13.33
2	Medium scientific orientation	23	76.67
3	High scientific orientation	3	10
Total		**30**	**100**
Mean-13.67			**S.D-1.84**

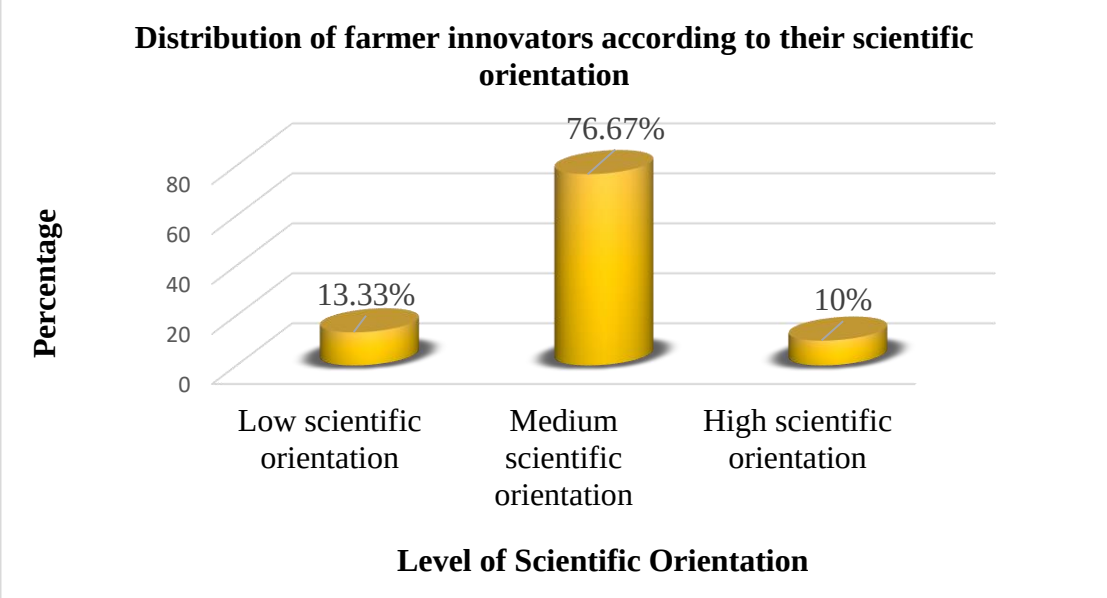


Fig. 4.12 Distribution of farmer innovators according to their scientific orientation

4.4.10 Risk bearing ability of the farmer innovators

The results from Table 4.13 shows that the innovators with medium risk bearing ability comprise the majority (83.33 %), followed by 10 per cent having a high risk-bearing ability and 6.67 per cent having a low risk-bearing ability. Figure 4.13, shown below, clearly depicts this.

Table 4.13 Distribution of farmer innovators according to their risk bearing ability

Sl No	Categories	Frequency(n=30)	Percentage
1	Low risk bearing ability	2	6.67
2	Medium risk bearing ability	25	83.33
3	High risk bearing ability	3	10
Total		**30**	**100**
Mean-12.5			**S.D-1.54**

This is because most of the farmer innovators have medium financial stability and occupational status, which provides them the ability to take a risk and cope with unfavourable situations. The results are in agreement with that of Bhagyalakshmi *et al.* (2003).

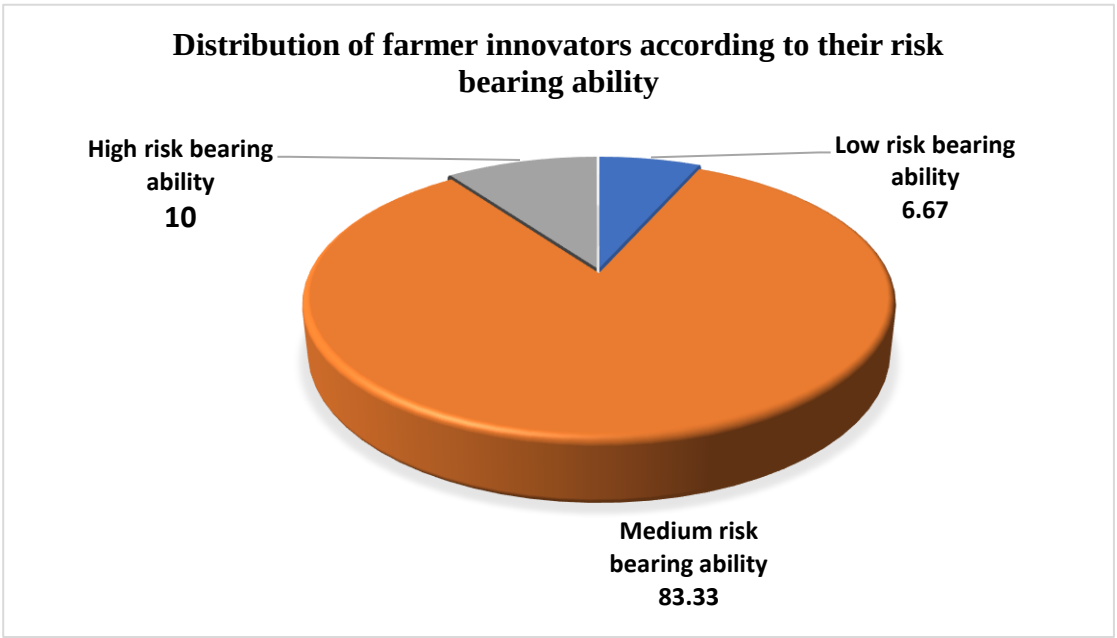


Fig. 4.13 Distribution of farmer innovators according to their risk bearing ability

4.4.11 Extension contact of the farmer innovators

From Table 4.3.11 and Figure 4.14, it is clear that most farmers (73.33%) belong to the category of having medium extension contact, and 13.33 per cent each belongs to the low and high extension contact. This may be because most farmers need support from extension personnel to develop their innovation further.

Table 4.14 Distribution of farmer innovators according to their extension contact

Sl No	Categories	Frequency(n=30)	Percentage
1	Low extension contact	4	13.33
2	Medium extension contact	22	73.33
3	High extension contact	4	13.33
Total		**30**	**100**
Mean-11.5			**S.D-2.54**

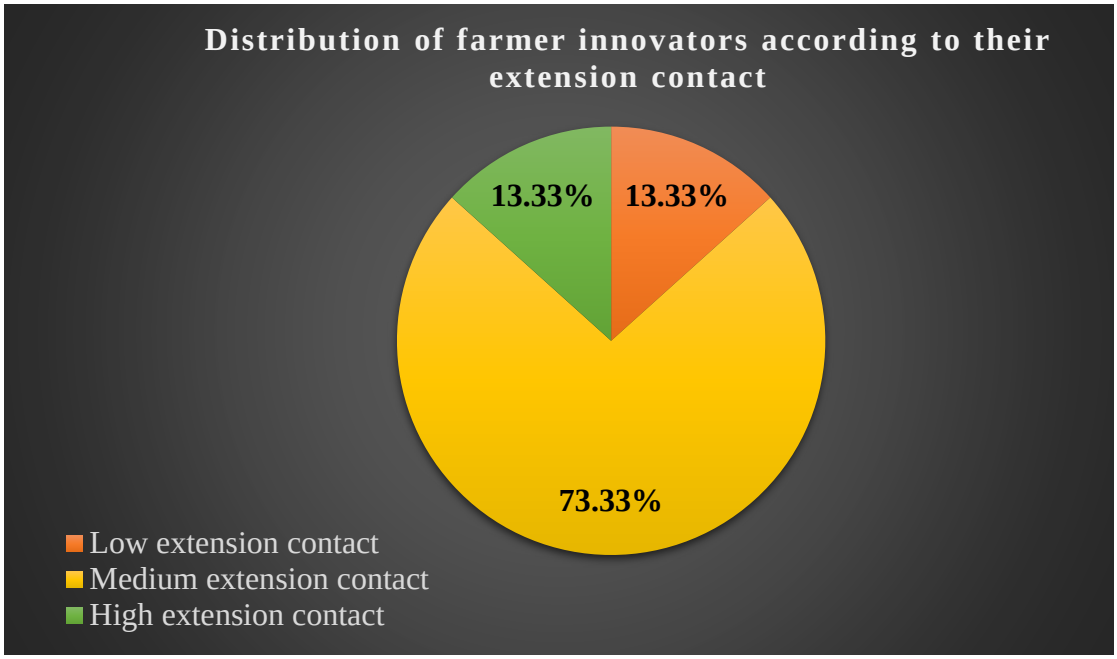


Fig. 4.14 Distribution of farmer innovators according to their extension contact

4.4.12 Institutional support received by the farmer innovators

The given table 4.3.12 depicts that the majority (70%) of the farmer innovators get in touch with supporting agencies like NIF (National Innovation Foundation), NABARD (National Bank for Agriculture and Rural Development), KSCSTE (Kerala

State Council for Science, Technology and Environment) for receiving support for their innovation, while 20 per cent of them approach agricultural research institutions like ICAR (Indian Council of Agricultural Research), State Agricultural University (SAU), Krishi Vigyan Kendras (KVKs) for seeking assistance. Only 6.67 per cent approaches Department of Agriculture and Farmer's Welfare and 3.33 per cent seeks technical institutions like NIT (National Institute of Technology), IIT (Indian Institute of Technology) for support.

Table 4.15 Distribution of farmer innovators according to their support received from various institutions

Sl No	Categories	Frequency	Percentage
1	Agricultural research institutions (ICAR, SAU, KVK)	6	20.00
2	Department of Agriculture and Farmer's Welfare	2	6.67
3	Technical Institutions (NIT, IIT...etc.)	1	3.33
4	Other supporting agencies (NIF, NABARD, KSCSCTE...etc.)	21	70
Total		**30**	**100**

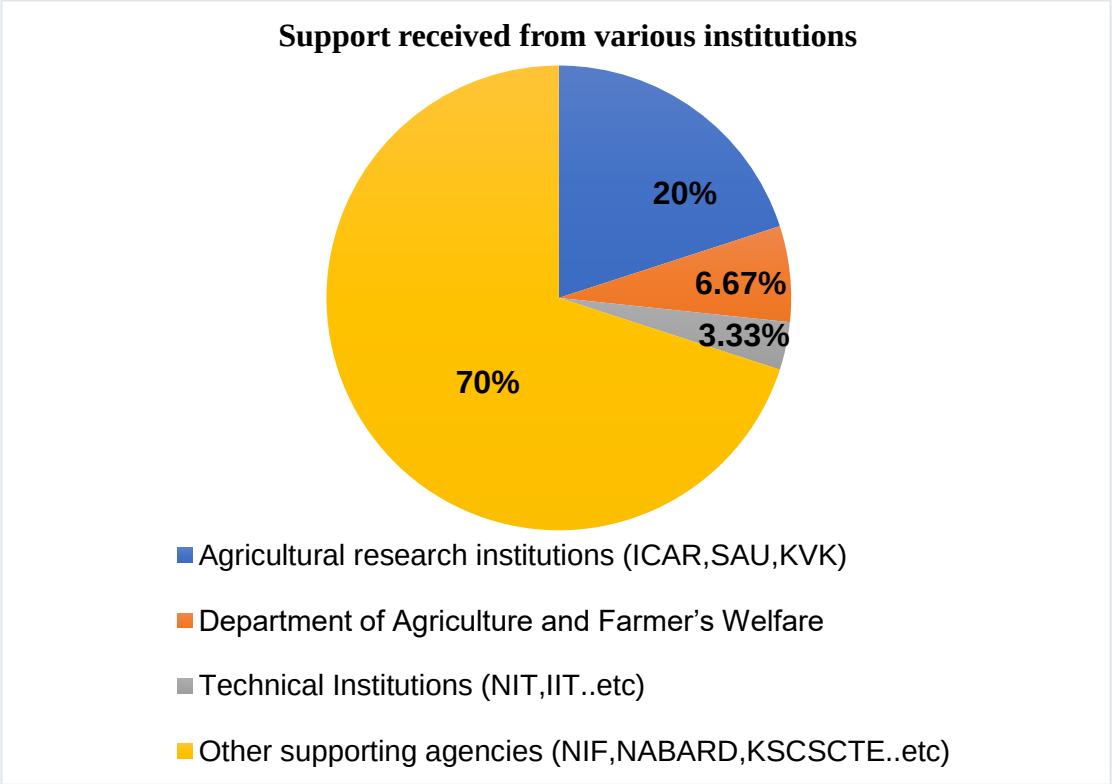


Figure 4.15 Distribution of farmer innovators according to their support received from various institutions

4.4.13 Economic motivation of the farmer innovators

Table 4.16 and Figure 4.16 shows that the innovators with medium economic motivation comprise the majority (76.67 per cent), followed by 16.67 per cent having a low economic motivation and 6.67 per cent with high economic motivation. The average living conditions of the farmer innovators make them profit motive to some extent. The results agree with that of Shankaraiah and Swamy (2012).

Table 4.16 Distribution of farmer innovators according to their economic motivation

Sl No	Categories	Frequency(n=30)	Percentage
1	Low economic motivation	5	16.67
2	Medium economic motivation	23	76.67
3	High economic motivation	2	6.67
Total		**30**	**100**
Mean-16.13			**S.D-2.48**

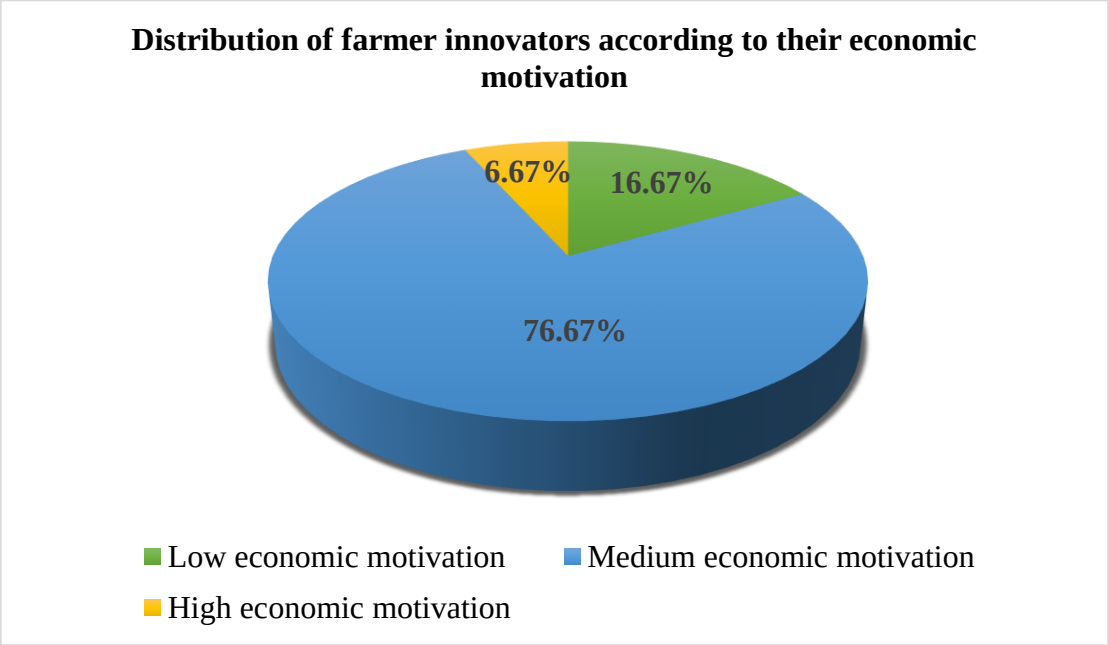


Figure 4.16 Distribution of farmer innovators according to their economic motivation

4.4.14 Self confidence of the farmer innovators

From Table 4.17 and Figure 4.17, it is clear that the innovators with medium self confidence comprise the majority (73.33 %), followed by 16.67 per cent having high self confidence and 10 per cent with low self confidence. This could be because a majority of them have good educational status, scientific orientation, and occupation, which built in them a kind of optimism that they can earn more through their hard work. Similar results have been reported by Barik (2013).

Table 4.17 Distribution of farmer innovators according to their self confidence

Sl No	Categories	Frequency(n=30)	Percentage
1	Low self confidence	3	10
2	Medium self confidence	22	73.33
3	High self confidence	5	16.67
Total		**30**	**100**
Mean-12.73			**S.D-2.33**

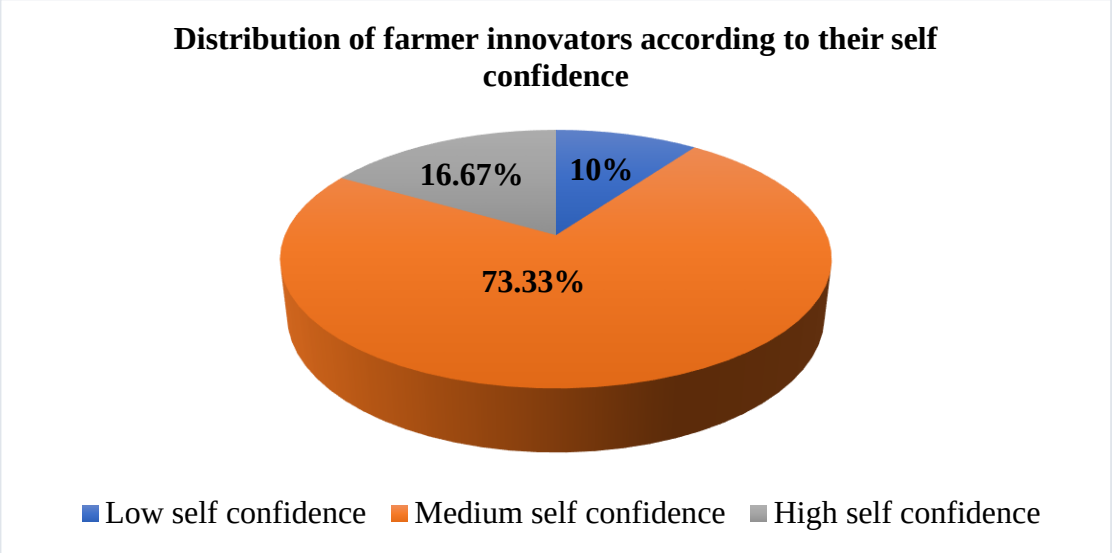


Fig. 4.17 Distribution of farmer innovators according to their self confidence

4.4.15 Source of finance available for the farmer innovators

From the data obtained from table 4.18 and Figure 4.18, the results show that the majority of the innovators (40 %) are depended on cooperative banks or societies as the source for getting financial help. About 33.33 per cent of the innovators put their own investment into the innovation, while 20 per cent of innovators depended on private agencies or relatives. Only 6.67 per cent of farmers relied on nationalized banks as a source of finance.

Table 4.18 Distribution of farmer innovators according to their source of finance

Sl No	Source of finance	Frequency(n=30)	Percentage
1	Nationalized banks	2	6.67
2	Cooperative banks/societies	12	40.00
3	Private agencies/relatives	6	20.00
4	Own investment	10	33.33
Total		**30**	**100**

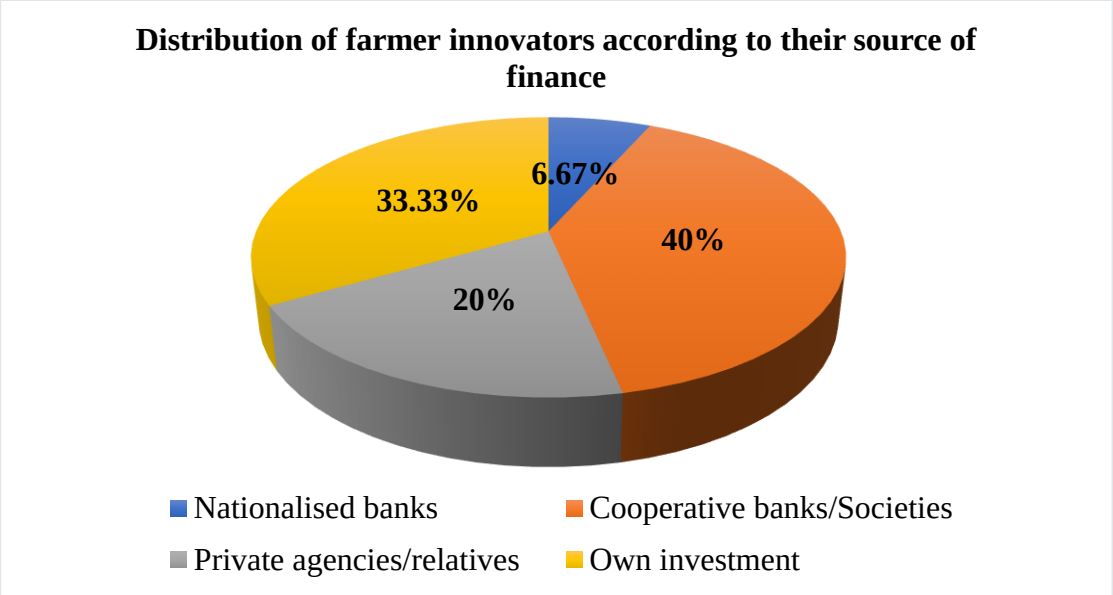


Fig. 4.18 Distribution of farmer innovators according to their source of finance

4.5 Analysis of farmer profile characteristics

4.5.1 Occupational status with farming experience

Table 4.19 Relationship between the occupational status of the farmer innovators with their farming experience

Categories	Farming experience (n=30)		
Occupational status	Low	Medium	High
Only farming	3 (10.0%)	5(16.7%)	1(3.3%)
Farming+labour	**8 (26.7%)**	2(6.7%)	0(0.0%)
Farming+service	6(20.0%)	1(3.3%)	0(0.0%)
Farming+business	2(6.7%)	0(0.0%)	2(6.7%)

Chi-square=14.947* **df=6**

***-Significant at 5% level**

From the above Table 4.19, it is understood that there exists a significant relationship between occupational status and farming experience. The majority (26.7%) of the farmer innovators with farming and labour as their occupation had low farming experience. This shows that those farmers who are also labourers work most of their time as manual labourers, limiting their experience in farming activities.

4.5.2 Occupational status with industrial experience

From Table 4.20, it is inferred that there exists a significant relationship between occupational status and industrial experience. The majority (26.7%) of the farmer innovators having only farming as their occupation had low industrial experience. This shows that they concentrated most of their life in only farming areas and had only limited industrial experience.

Table 4.20 Relationship between the occupational status of the farmer innovators with their industrial experience

Categories	Industrial experience (n=30)		
Occupational status	Low	Medium	High
Only farming	**8(26.7%)**	0(0.0%)	1(3.3%)
Farming+labour	3(10.0%)	5(16.7%)	2(6.7%)
Farming+service	2(6.7%)	3(10.0%)	2(6.7%)
Farming+business	0(0.0%)	3(10.0%)	1(3.3%)

Chi-square=12.930* **df=6**

***-Significant at 5% level**

4.5.3 Industrial experience with innovativeness

Table 4.21 Relationship between the industrial experience of the farmer innovators with their innovativeness

Categories	Innovativeness (n=30)		
Industrial experience	Low	Medium	High
Low	6(20.0%)	7(23.3%)	0(0.0%)
Medium	1(3.3%)	**8(26.7%)**	2(6.7%)
High	1(3.3%)	2(10.0%)	3(10.0%)

Chi-square=11.919 **df=4**

***-Significant at 5% level**

From Table 4.21, it is shown that there exists a relationship between industrial experience and the innovativeness of the innovators. The majority (26.7%) of the farmer innovators having medium industrial experience were having medium innovativeness. This could result from the fact that when they are associated with any industry or allied

sectors, which makes them develop new and innovative solutions that can be applied to their daily life situations.

4.6 Attributes of the farmer innovations

From Table 4.22 given below, it is understood that among the eight attributes of innovations, a majority (66.67%) of farmer innovations under the high category had trialability as the attribute, followed by compatibility (50 %) and 30 per cent with communicability. In the medium category, 60 per cent of the innovations have observability and communicability, followed by relative advantage (50%) and complexity in use (43.33 %).In the low category, 73.33 per cent of innovations have complexity in design, followed by complexity in use (56.67%) and observability(16.67 %). The results are indicated in Figure 4.19.

Table 4.22 Distribution of farmer innovations based on their perceived attributes (n=30)

Sl. No.	Attributes	Category	Range of score	Frequency	Percentage	Mean	S.D
1	**Relative advantage**	Low	<74.70	3	10.00	87.22	12.52
		Medium	74.70-99.74	15	50.00		
		High	>99.74	12	40.00		
2	**Observability**	Low	<70.29	5	16.67	81.38	11.09
		Medium	70.29-92.47	**18**	**60.00**		
		High	>92.47	7	23.33		
3	**Compatibility**	Low	<74.70	3	10.00	87.22	12.52
		Medium	74.70-99.74	12	40.00		
		High	>99.74	15	50.00		
4	**Complexity in use**	Low	<51.44	15	50.00	66.11	14.67
		Medium	51.44-80.78	13	43.33		
		High	>80.78	2	6.67		
5	**Complexity in design**	Low	<30.11	**22**	**73.33**	54.16	24.04
		Medium	30.11-78.21	6	20.00		
		High	>78.21	2	6.67		
6	**Discontinuity**	Low	<35.68	17	56.67	54.72	19.09
		Medium	35.68-73.76	11	36.67		
		High	>73.76	2	6.67		

7	**Communicability**	Low	<74.46	3	10	86.11	11.64
		Medium	74.46-97.75	**18**	**60**		
		High	>97.75	9	30		
8	**Trialability**	Low	<74.11	2	6.67	86.38	12.28
		Medium	74.11-98.66	8	26.67		
		High	>98.66	**20**	**66.67**		

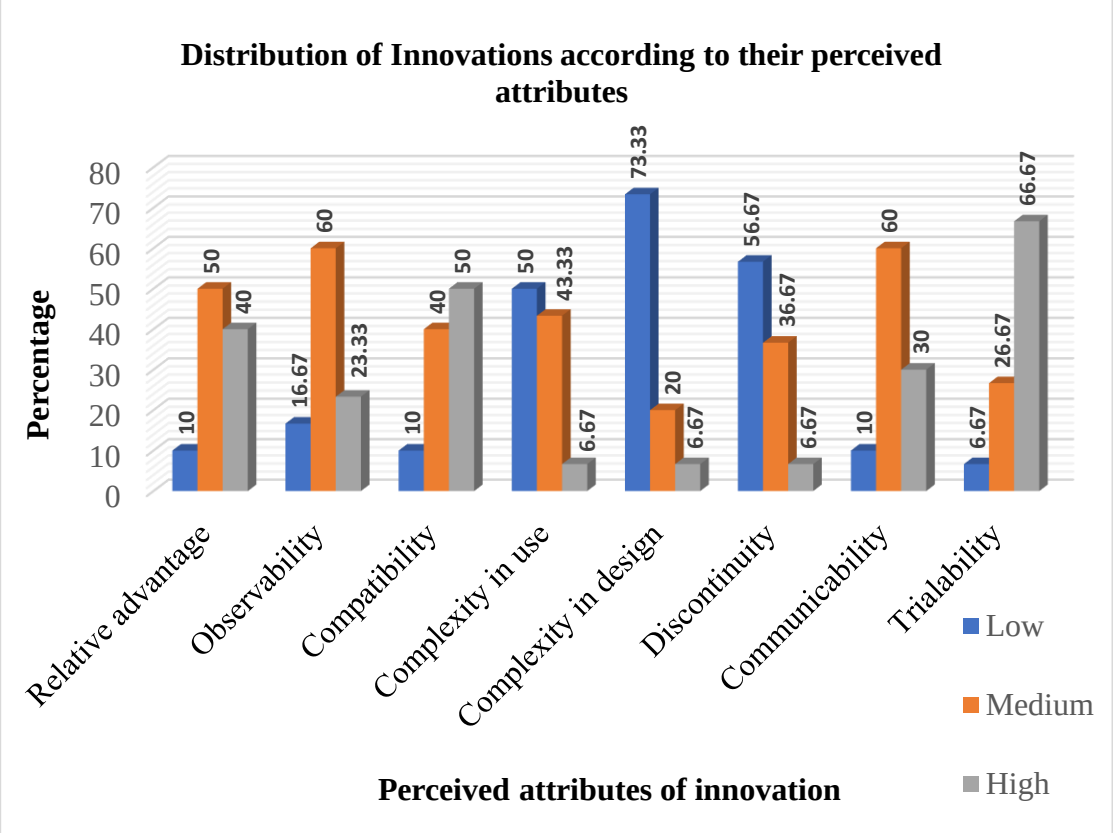


Fig. 4.19 Distribution of farmer innovations based on their perceived attributes

4.6.1 Overall attributes of the innovations

From Table 4.23 and Figure 4.20, it is clear that the overall attribute score based on the cumulative scores of all the attributes found that the majority (70 %) of the innovations belonged to the medium attributes category, whereas 16.67 per cent in the high attributes category, and remaining 13.33 per cent in the low attributes category

Table 4.23 Distribution of innovations according to their overall attributes (n=30)

Sl No	Attributes of the innovation	Range of indices	Frequency	Percentage
1	Low	<0.68	4	13.33
2	Medium	0.68-0.81	21	70.00
3	High	>0.81	5	16.67
Mean-0.75				**S.D**-0.07

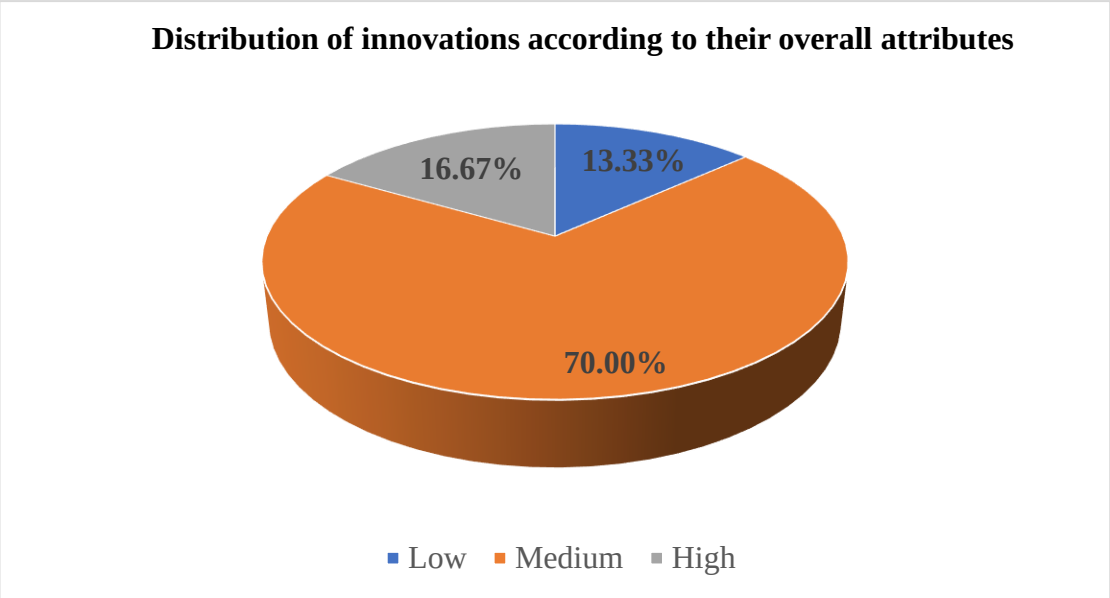


Figure 4.20 Distribution of innovations according to their overall attributes

4.7 Analysis of attributes of farmer innovations with innovation stages

The analysis of the stages of innovation development with the attributes of the selected innovations was carried out and studied.Conducting such an analysis can help to analyze how far the marketing of an innovation varies among the attributes.The result obtained after analyzing the innovation stages with relative advantage, observability, compatibility, complexity in use, complexity in design, discontinuity, communicability and trialability are as follows:

4.7.1 Relative advantage with stages of innovation development

Table 4.24 Relationship between stages of innovation development of the farmer innovations with their relative advantage

Categories	**Relative advantage (n=30)**		
Stage of innovation development	**Low**	**Medium**	**High**
Upto prototype stage	2(6.7%)	1(3.3%)	0(0.0%)
Upto minimum viable product stage	0(0.0%)	3(10.0%)	2(6.7%)
Upto production stage	0(0.0%)	3(10.0%)	0(0.0%)
Upto commercialization stage	1(3.3%)	8(26.7%)	**10 (33.3%)**

Chi-square=14.712* **df=6**

***-Significant at 5% level**

From Table 4.24, it is understood that there exists a positive significant relationship between the stage of innovation development and relative advantage. The majority (33.3 %) of the innovations that have reached the commercialization stage have a high relative advantage. According to customer acceptance and benefits over the competitors, innovations have advanced from one stage to the next. The market will favour innovations that have shown to be superior to the ones already in use.

4.7.2 Observability with stages of innovation development

Table 4.25 Relationship between stages of innovation development of the farmer innovations with their observability

Categories	Observability (n=30)		
Stage of innovation development	Low	Medium	High
Upto prototype stage	3(10.0%)	0(0.0%)	0(0.0%)
Upto minimum viable product stage	0(0.0%)	5(16.7%)	0(0.0%)
Upto production stage	1(3.3%)	1(3.3%)	1(3.3%)
Upto commercialization stage	1(3.3%)	**12(40.0%)**	6(20.0%)

Chi-square=21.385*	**df=6**
***-Significant at 5% level**	

From table 4.6.2, it is inferred that the majority (40 %) of the innovations which have reached upto commercialization stage have medium observability. New items are not always accepted by people. They base their decisions on an innovation's observable characteristics, and this observability facilitates their commercialization.

4.7.3 Compatibility with stages of innovation development

Table 4.26 Relationship between stages of innovation development of the farmer innovations with their compatibility

Categories	Compatibility (n=30)		
Stage of innovation development	Low	Medium	High
Upto prototype stage	2(6.7%)	1(3.3%)	0(0.0%)
Upto minimum viable product stage	0(0.0%)	2(6.7%)	3(10.0%)
Upto production stage	0(0.0%)	3(10.0%)	0(0.0%)
Upto commercialization stage	1(3.3%)	6(20.0%)	**12(40.0%)**

Chi-square=15.696* **df=6**

***-Significant at 5% level**

Table 4.26 clearly shows that the majority (40%) of the innovations that had reached upto commercialization stage showed high compatibility. The society is more likely to embrace an innovation and for it to spread more quickly when it is compatible with the socioeconomic context that already exists.

4.7.4 Complexity in use with stages of innovation development

Table 4.27 Relationship between stages of innovation development of the farmer innovations with their complexity in use

Categories Stage of innovation development	Complexity in use (n=30)		
	Low	**Medium**	**High**
Upto prototype stage	1(3.3%)	2(6.7%)	0(0.0%)
Upto minimum viable product stage	4(13.3%)	1(3.3%)	0(0.0%)
Upto production stage	1(3.3%)	2(6.7%)	0(0.0%)
Upto commercialization stage	**9(30.0%)**	8(26.7%)	2(6.7%)

Chi-square=13.199* **df=6**

***-Significant at 5% level**

Table 4.27 shows that the majority (30 %) of the innovations that had reached upto commercialization stage showed low complexity in use. Potential adopters will find it more challenging to implement innovations into their life the more complex they are. Most of the time, potential adopters don't take their time to understand how to use an innovation. Innovations are more likely to be adopted if they are simple to understand.

4.7.5 Complexity in design with stages of innovation development

Table 4.28 Relationship between stages of innovation development of the farmer innovations with their complexity in design

Categories	Complexity in design (n=30)		
Stage of innovation development	Low	Medium	High
Upto prototype stage	1(3.3%)	0(0.0%)	2(6.7%)
Upto minimum viable product stage	5(16.7%)	0(0.0%)	0(0.0%)
Upto production stage	1(3.3%)	2(6.7%)	0(0.0%)
Upto commercialization stage	**15(50.0%)**	4(13.3%)	0(0.0%)

Chi-square=13.354* **df=6**

***-Significant at 5% level**

Table 4.28 clearly shows that the majority (50 %) of the innovations that had reached upto the commercialization stage showed low complexity in design. Less sophisticated innovation designs require less complicated effort for setting up and maintaining them. It will have a clear understanding of its functioning, which facilitates market acceptance of such innovations.

4.7.6 Discontinuity with stages of innovation development

Table 4.29 Relationship between stages of innovation development of the farmer innovators with their discontinuity

Categories	Discontinuity (n=30)		
Stage of innovation development	Low	Medium	High
Upto prototype stage	0(0.0%)	1(3.3%)	2(6.7%)
Upto minimum viable product stage	5(16.7%)	0(0.0%)	0(0.0%)
Upto production stage	2(6.7%)	1(3.3%)	0(0.0%)
Upto commercialization stage	**10(33.3%)**	9(30.0%)	0(0.0%)

Chi-square=11.784* df=6

***-Significant at 5% level**

Table 4.29 shows that the majority (33.3%) of the innovations that had reached upto the commercialization stage showed low discontinuity. The innovations with low discontinuity rates will succeed in reaching the commercialization stage, whereas those with high discontinuity possibilities will be automatically eliminated from society.

4.7.7 Communicability with stages of innovation development

Table 4.30 Relationship between stages of innovation development of the farmer innovations with their communicability

Categories	Communicability		(n=30)
Stage of innovation development	Low	Medium	High
Upto prototype stage	1(3.3%)	2(6.7%)	0(0.0%)
Upto minimum viable product stage	0(0.0%)	3(10.0%)	2(6.7%)
Upto production stage	1(3.3%)	0(0.0%)	2(6.7%)
Upto commercialization stage	1(3.3%)	**13(43.3%)**	5(16.7%)

Chi-square=8.737 **df=6**

***-Significant at 5% level**

Table 4.30 shows that the majority (43.3%) of the innovations that had reached upto the commercialization stage showed medium communicability. This is due to the fact that the majority of innovators either fail to inform society about their innovations or are not familiar with the numerous communication channels and how to use them. As a result, the innovation is limited in its commercialization to a small area and does not spread widely.

4.7.8 Trialability with stages of innovation development

Table 4.31 Relationship between stages of innovation development of the farmer innovators with their trialability

Categories	Trialability (n=30)		
Stage of innovation development	Low	Medium	High
Upto prototype stage	2(6.7%)	1(3.3%)	0(0.0%)
Upto minimum viable product stage	0(0.0%)	4(13.3%)	1(3.3%)
Upto production stage	0(0.0%)	0(0.0%)	3(10.0%)
Upto commercialization stage	0(0.0%)	3(10.0%)	**16(53.3%)**

Chi-square=16.286 df=6

***-Significant at 5% level**

From table 4.31, it is inferred that the majority (53.3 %) of the innovations that had reached upto the commercialization stage of their development had high trialability. This is due to the fact that prospective customers prefer to test out innovations before purchasing them, which helps to further the commercialization of the innovation.

4.8 Relationship of independent variables with attributes of farmer innovations using Spearman's rank correlation coefficient.

The relationship of independent variables with dependent variables is analyzed using Spearman's rank correlation coefficient method. The results were interpreted in Table 4.32, and it is understood that the independent variables, such as educational status, annual income, institutional support, and innovativeness, had a positive significant relationship with the attributes of innovation at 0.05 per cent level. The independent variables like risk-bearing ability and economic motivation had a negatively significant relationship at 0.05 per cent level. At the same time, industrial experience and self confidence possess a positive significant relationship at 0.01per cent level.

Table 4.32 Factors affecting attributes of farmer innovations

Sl No	Independent Variable	Correlation coefficient
1	Educational status	0.373*
2	Annual income	0.381*
3	**Industrial experience**	**0.466****
4	Institutional support	0.305*
5	Innovativeness	0.438*
6	**Self confidence**	**0.574****
7	Risk bearing ability	-0.377*
8	Economic motivation	-0.378*
*Correlation is significant at 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)		

The result indicated that the farmers having good industrial experience and self confidence can contribute more towards enhancing the overall attributes of the farmer innovations. Such farmer innovators can apply their industry knowledge and skills to develop a better product that is user-friendly and can quickly solve the issues faced. Along with this, the innovativeness level of the farmer, their income, educational status, and the support that the farmer receives from various institutions in developing their innovations can positively contribute to the betterment of his innovation.

On the other hand, the innovator's risk-bearing ability won't always produce a better product. The farmer may face an unexpected loss during his innovation development, which may further doubt his progress. Also, those with high economic motivation will always see their product in economic terms only and not as an innovation with qualities essential for the betterment of society.

4.9 Study of perceived attributes by the expert group

The innovations developed by the farmer innovators were studied by the expert group, and each of them got the opportunity to rate all 30 innovations. The expert group ranked these innovations based on the perceived attributes of the selected innovations. The study has shown a high degree of concordance among the expert groups to rank.

4.9.1 Ranking of innovations based on their relative advantage by the expert group

Table 4.33 Mean rank assigned for the innovations based on their relative advantage

Sl No	Innovation	Mean Rank	Rank
1	**'Poultry mitra' raking machine**	28.25	**1**
2	**Refined pepper thresher**	27.68	**2**
3	**Earth digger for farmers**	26.98	**3**

Following a ranking of the innovations based on their relative advantage, the 'Poultry Mitra' concept came first, followed by the 'Refined pepper thresher' and the 'Earth digger for farmers'. The respondents rated the innovations based on their relative advantage with Kendall's coefficient of concordance (W) value of **0.823** at a 1% significance level, indicating substantial agreement amongst the respondents.

4.9.2 Ranking of innovations based on their observability by the expert group

Table 4.34 Mean rank assigned for the innovations based on their observability

Sl No	Innovation	Mean Rank	Rank
1	**Automatic solar dryer**	28.92	**1**
2	**Agro easy tapioca plucker**	26.55	**2**
3	**Coconut dehusker with gear**	26.00	**3**

The concept of the "Automatic solar dryer" took top place in a rating of the innovations based on their observability, followed by the "Agroeasy tapioca plucker" and the "Coconut dehusker with gear." A Kendall's coefficient of concordance (W) value of **0.777** at a 1% level of significance indicates that there is substantial agreement among the respondents on how the respondents ranked the innovations based on their observability.

4.9.3 Ranking of innovations based on their compatibility by the expert group

Table 4.35 Mean rank assigned for the innovations based on their compatibility

Sl No	Innovation	Mean Rank	Rank
1	**Wooden paddy thresher**	29.70	**1**
2	**Modified earth auger for digging pits**	29.30	**2**
3	**Multipurpose motorized wheelbarrow**	18.43	**3**

The "wooden paddy thresher" concept was positioned in the first place, followed by the "Modified earth auger for digging trenches" and the "Multipurpose motorized wheelbarrow" when ranked according to the compatibility of innovations. A Kendall's coefficient of concordance (W) value of **0.535** at a 1% significance level indicates that the respondents strongly agreed when rating the innovations based on their compatibility.

4.9.4 Ranking of innovations based on their complexity in design by the expert group

Table 4.36 Mean rank assigned for the innovations based on their complexity in design

Sl No	Innovation	Mean Rank	Rank
1	**Intelligent coffee bean harvester**	27.52	**1**
2	**Air cooler cum humidifier**	27.15	**2**
3	**Automatic rubber tapping machine**	27.10	**3**

Following a rating of the innovations based on their design complexity, the 'Intelligent coffee bean harvester' came out on top, followed by the 'Air cooler cum humidifier' and the 'Automatic rubber tapping machine.' The respondents scored the innovations based on their design complexity, with Kendall's coefficient of concordance (W) value of **0.802** at a 1% significance level reflecting strong agreement among them.

4.9.5 Ranking of innovations based on their complexity in use by the expert group

Table 4.37 Mean rank assigned for the innovations based on their complexity in use

Sl No	Innovation	Mean Rank	Rank
1	**Climbing gear for trees**	25.80	**1**
2	**Air cooler cum humidifier**	25.03	**2**
3	**Intelligent coffee bean harvester**	24.93	**3**

The "Climbing gear for trees" was chosen after the innovations were ranked based on how complex they were to use. It was followed by the "Air cooler cum humidifier" and the "Intelligent coffee bean harvester." The respondents rated the innovations based on their usage complexity, with Kendall's coefficient of concordance (W) of **0.780** at a 1% significance level, indicating substantial agreement.

4.9.6 Ranking of innovations based on their discontinuity by the expert group

Table 4.38 Mean rank assigned for the innovations based on their discontinuity

Sl No	Innovation	Mean Rank	Rank
1	**Automated rubber tapper**	27.80	**1**
2	**Hand-operated arecanut peeler**	27.08	**2**
3	**Coconut dehusking machine**	26.78	**3**

When ranked according to the discontinuity of innovations, the "Automated rubber tapper" concept came out on top, followed by the "Hand operated arecanut peeler" and the "Coconut dehusking machine." When the respondents rated the innovations based on their discontinuity, they substantially agreed, as shown by Kendall's coefficient of concordance (W) value of **0.790** at a 1% significance level.

4.9.7 Ranking of innovations based on their communicability by the expert group

Table 4.39 Mean rank assigned for the innovations based on their communicability

Sl No	Innovation	Mean Rank	Rank
1	**Wooden paddy thresher**	28.95	**1**
2	**Arrowroot powdering machine**	25.93	**2**
3	**Poultry litter raking machine for small farms**	25.85	**3**

According to the communicability of the ideas, the "Wooden paddy thresher" concept came out on top, followed by the "Arrowroot powdering machine" and the "Poultry litter raking machine for small farms." At a 1% significance level, Kendall's coefficient of concordance (W) value of **0.735** shows that the respondents highly concurred when ranking the innovations based on their communicability.

4.9.8 Ranking of innovations based on their trialability by the expert group

Table 4.40 Mean rank assigned for the innovations based on their trialability

Sl No	Innovation	Mean Rank	Rank
1	**Arecanut wonder climber**	27.18	**1**
2	**Agro easy tapioca plucker**	26.67	**2**
3	**Multipurpose motorized wheelbarrow**	26.17	**3**

The "Arecanut wonder climber" idea, followed by the "Agro easy tapioca plucker" and the "Multipurpose motorized wheelbarrow" concept, came out on top when it came to trialability. A Kendall's coefficient of concordance (W) value of **0.738** at the 1% significance level reveals that the respondents strongly agreed when assessing the innovations based on their trialability.

4.10 Constraints faced by farmers in promoting farmer innovations

Constraints faced by farmer innovators in promoting farmer innovations were analyzed using the Garret ranking method. Several constraints faced by farmer innovators were listed out in the interview schedule, and they were asked to rank them according to the importance felt by them and the rankings were obtained in each category.

Table 4.41 Technical constraints in promoting farmer innovations

Sl. No.	Problem faced	Score	Rank
1	Lack of knowledge	55.63	1
2	Lack of expertise for validation	53.27	2
3	Lack of separate staff	50.43	3
4	Lack of design support for development	48.90	4
5	Location specificity of the innovations	47.30	5
6	Scouting and identification problem	45.80	6

Table 4.41 indicates that the significant technical constraint faced in promoting farmer innovation is the lack of proper knowledge regarding further stages of innovation development, followed by a lack of expertise for validation. This may be because the innovators are either unaware or are not participating in the training provided by various institutions or not getting proper orientation. This may be because of the involvement of the participants in other non-farming jobs.

Table 4.42 Infrastructural constraints in promoting farmer innovations

Sl. No.	Problem faced	Score	Rank
1	Lack of testing facilities for innovation	55.63	1
2	Lack of mass production centers	53.27	2
3	Lack of proper marketing infrastructure	50.43	3
4	Lack of incubation centers	48.90	4
5	Lack of research support	47.30	5
6	Lack of transportation facilities	45.80	6

Table 4.42 indicates that the major infrastructural constraint in promoting farmer innovation is the lack of testing facilities for innovation, followed by lack of mass production centers. This could be because of the shortage of available facilities associated with innovations in machinery in the whole state.

Table 4.43 Economic constraints in promoting farmer innovations

Sl. No.	Problem faced	Score	Rank
1	Lack of financial support from the Government	55.63	1
2	High consultancy and overhead cost	53.27	2
3	Non-availability of commercializing partners	50.43	3
4	Disagreement in sharing of benefits of innovator and organization	48.90	4
5	High input cost at purchase	47.30	5
6	No insurance coverage	45.80	6

Table 4.43 indicates that the major economic constraint faced in promoting farmer innovation is the lack of Government financial support, followed by high consultancy and overhead costs. This could be because most of the farmer innovations are not filling up the required eligibilities and criteria mentioned, which is necessary for granting support from the government side.

Table 4.44 Administrative constraints in promoting farmer innovations

Sl. No.	Problem faced	Score	Rank
1	Work overload and involvement of officials in other sectors	55.63	1
2	Political interference	53.27	2
3	Lack of networking between organizations	50.43	3
4.	No standard set of indicators for validation	48.90	4
5	Job insecurity of temporary workers	47.30	5
6	IPR protection and related issues	45.80	6

Table 4.44 indicates that the major administrative constraint faced in promoting farmer innovation is the work overload and involvement in other sectors, followed by political interference. This may be because most of the innovations in which the officials work are not associated with the agricultural machinery sector and includes other sectors like crop improvement, food processing..etc.

4.11 Institutional support received for the development of farmer innovations

The central and state governments support innovative ideas in various ways. Services like financing, technical guidance, equipment support, training, marketing, and providing subsidies and grants are supported by several institutions. The institutions from which the farmer innovators got assistance are listed in Table 4.45.

4.11.1 Kerala Agricultural University Agri Business Incubator (KAU RKVY-RAFTAAR ABI)

Being the pioneer institution in agriculture and allied sectors, the Kerala Agricultural University is providing support through the KAU RAFTAAR Agri-Business Incubation (KAU- RABI) centre to take forward the vision and objectives of RKVY RAFTAAR. Reputed institutions in the country would be associating with this initiative to provide technical support and train the personnel and innovators.

The following components will be executed under RKVY-RAFTAAR:

- Strengthening existing agri business incubators for integrated rejuvenation and development and setting up new ones
- Seed stage funding of RABI incubatees
- Idea/Pre-seed stage funding of agripreneurs
- Startup incubation training programme

Table 4.45 Institutional support received for farmer innovations

Sl. No.	Innovation	Major institutional support
1	Automatic tender coconut peeling machine	KAU ABI
2	Poultry litter raking machines for small farms	KSCTE
3	Rubber smart tapper	KAU ABI
4	Rain guard for rubber	KAU ABI

5	Earth digger for farmers	NABARD
6	Hand-operated arecanut dehusker	KSCSTE
7	Intelligent coffee bean harvester	KSCSTE
8	Smart latex collector	KAU ABI
9	Polybag filling device	NIF
10	Arecanut wonder climber	NABARD
11	Air cooler cum humidifier	KSCSTE
12	Poultry Mitra-the poultry raking machine	KSCSTE
13	Wooden paddy thresher	KSCSTE
14	Agro easy tapioca plucker	KSCSTE
15	Climbing gear for trees	KSCSTE
16	Coconut dehusker with gear	KSCTE
17	Pepper thresher	NIF
18	Hand-operated arecanut peeler	NABARD
19	Nutmeg desheller	NIF
20	Arrowroot powdering machine	NIF
21	Automatic rubber tapping machine	KAU ABI
22	Refined pepper thresher	NABARD
23	Black pepper plucking tool	NIF
24	Coconut dehusking machine	Krishibhavan
25	Automated rubber tapper	KAU ABI
26	Automatic solar dryer	Krishibhavan
27	Paddy cleaner	KSCSTE
28	Multipurpose motorized wheelbarrow	KSCTE
29	Cardamom washing machine	NIF
30	Modified earth auger for digging pits	NIT

- Focused group mentorship: Individual mentoring sessions with a diverse group of subject-matter experts and specially designed mentoring sessions
- Regulatory and advisory guidelines for market research, strategic analysis, and product creation

- Establishing an entity, creating a business strategy, setting product prices, obtaining capital, and exploring prospects
- Company establishment, government clearances, etc.
- Intellectual property rights, such as trademarks, copyright, and patent applications.
- Sessions with entrepreneurs and innovators to promote innovation and IPR protection for the commercialization of technologies.

KAU-RABI is implementing its objective through the following two phases:

1) **Promotion of Agriculture through Commercialization and Entrepreneurship (PACE**): An initiative of the KAU Agri-Business Incubator, a launchpad for agri-startups, is supported by the RKVY-RAFTAAR scheme of the Ministry of Agriculture and Farmer's Welfare, Government of India. It is a specially created incubation programme for early-stage agri-startups to foster innovation and entrepreneurship in agribusiness and related industries. The start-up will get an initial grant-in-aid of up to Rs. 25 Lacs (commercially launched). Additionally, until start-ups complete the incubation phase, extensive marketing and mentoring support will be provided by professionals from the field.

- **RAISE (Realising and Augmenting Innovations for Startup Enterprises):** An initiative of the KAU Agri-Business Incubator, supported by the RKVY-RAFTAAR Scheme of the Ministry of Agriculture and Farmer's Welfare, Government of India, is a launchpad for agripreneurship orientation. It is an incubation programme specially created for early-stage agri-startups to foster innovation and entrepreneurship in agribusiness and related industries.

  The important functions include:

- From idea to product prototype (Early-stage product development)
- Access to research facilities, technical specialists, patent filing, and substantial mentorship assistance would be available for "proof of concept" and "promising Ideas." This will make it easier to create a workable, scaleable product prototype.

- An eight-week internal residency programme has been designed to guide businesses on their successful path.
- Successful startups will be connected to those who were chosen.
- The selected incubators will get a fellowship payment of Rs. 10,000 per month as a stipend for the in-house residency programme.
- Up to Rs. 5 lakhs in grants-in-aid are available to selected entrepreneurs for prototype development.

4.11.2 National Initiative for Developing and Harnessing Innovations (NIDHI) by National Institute of Technology (NIT) Calicut

National Initiative for Developing and Harnessing Innovations (NIDHI) is an umbrella programme conceived and developed by the Department of Science & Technology, Government of India, for nurturing ideas and innovations (knowledge-based and technology-driven) into successful startups.

NIDHI-PRomotion and Acceleration of Young and Aspiring technology entrepreneurs (NIDHI-PRAYAS) – Support from idea to prototype is the scheme under NIDHI aimed at addressing the gap in the very early stage idea/ proof of concept funding. The NIDHI-PRAYAS programme focuses on addressing the idea to prototype the funding gap.

The priority areas for supporting innovations under the NIDHI PRAYAS programme are manufacturing, agriculture, healthcare, clean tech, energy, water, and Internet of Things (IoT) NANO Technology and other allied technology areas.

NIDHI-PRAYAS is positioned as a pre-incubation initiative. The prayasee will get access to the following:

- Infrastructural support
- Prototype grant
- Mentorship
- Fab lab
- Facilities of the host institute
- Business facilitation

The prayasee can get a prototype grant limited to a maximum of Rs 10.00 lakhs for making the prototype of the innovative idea.

4.11.3 National Innovation Foundation (NIF)

The National Innovation Foundation (NIF) is dedicated to making India innovative via the documentation, enhancement, and protection of the intellectual property rights of exceptional traditional knowledge holders and current unaided technological innovators. By fostering lateral learning throughout local communities, it seeks to encourage commercial and non-commercial innovation diffusion by offering low-cost, affordable solutions to enduring and escalating problems. The National Innovation Foundation (NIF) aims to foster an innovation-driven society by honoring outstanding grassroots innovators, assisting in the transformation of innovations with economic potential into products that can be produced commercially (either by the innovator themselves or through licensing of the innovation to another commercial enterprise), and connecting grassroots innovators to the formal science and technology system to obtain feedback on innovations where necessary.

The NIF attempts to maintain components of the Honey Bee philosophy in these activities by giving innovators prominence, obtaining their approval before sharing information about their ideas, and engaging them in decision-making. The NIF's most ambitious plan calls for nothing less than a complete transformation of rural India via the development of a new kind of innovation-driven entrepreneurship.

NIF Incubation and Entrepreneurship Council (NIF-ientreC).

It was established in 2015 with funding assistance from the Department of Science & Technology (DST) to incubate and commercialize technology ideas and discoveries from students and grassroots innovators across the country.

To help innovators and entrepreneurs succeed in their activities, NIF IentreC plans to build a complete support network. NIFientreC helps innovators and entrepreneurs transform their ideas and innovations into marketable technology products and processes by offering in-person and remote mentoring services. Additionally, it offers them business advice and support for starting and running a successful business endeavor, facilitating the spread of technical innovation across India and even beyond India.

The support provided is as follows :

- Mentoring in business and technology
- Networking and promoting a business
- Development of skills and capacity
- Assistance with regulations and compliance
- Transfer of technology and commercialization
- Technology validation and prototyping

4.11.4 Kerala State Council for Science, Technology and Environment (KSCSTE)

The Kerala State Council for Science, Technology and Environment (KSCSTE) is an autonomous body under the Ministry of S&T, Kerala, constituted in November 2002 to be an agency for change and development through Science and Technology. Rural technologies are technologies developed by/ arising from the rural sector or have direct applications to the rural sector, which can be upgraded and perfected for more comprehensive applications and employment generations in the rural sector.

Rural Innovators meet are conducted annually to encourage rural innovations from the State and promote rural innovators by providing a platform for them to exhibit and present their innovations, interact with scientists and fellow innovators and recognize the innovators by giving prizes to the best innovations exhibited in the event.

The objectives of rural innovators meet include:

- Provide opportunities for technologists working in rural areas to showcase and disseminate their technologies.
- Provide opportunities for experts working in rural areas to share knowledge with each other and exchange ideas with scientists in research institutions.
- Select technologies with more potential and tie up with research institutes for technology and lead to entrepreneurship
- It provides a platform for providing science and technology inputs to the innovators to understand marketing methods, IPR issues, microfinancing, technology transfer, etc.
- Provide the villagers an opportunity to see and understand the technologies.

- Rural researchers who have developed the best technologies will be selected and encouraged with prizes and included in the Rural Technology Programme (RTP)
- Provide knowledge to rural researchers about intellectual property law and related information.
- Rural Innovations Awards are given to the best projects contested in RIM with a prize of Rs 1 Lakh.

4.11.5 National Bank for Agriculture and Rural Development (NABARD)

NABARD-Rural Innovation Fund (RIF) is a fund designed to support innovative, risk-friendly, unconventional experiments in farm, non-farm and micro-finance sectors that could potentially promote livelihood opportunities and employment in rural areas. The type of projects that can be supported under RIF includes:

- All innovations and related activities in the farm, rural non-farm and microfinance sectors can access the RIF. Assistance from RIF will be available for all activities which are in keeping with the guiding principles of RIF and specifically those which provide technology and skill up gradation, inputs supply and market support leading to the promotion of viable enterprises, sustainable employment, infrastructure development, improved flow and access of credit to rural entrepreneurs.
- Undertake innovations to improve the efficiency of credit delivery and other support services to the rural resource poor.
- Patenting innovations leading to commercialization of the idea through licensing or otherwise.

Support available under RIF can be in the form of loan/grant/ incubation fund support or a mix of all three components. The support would be need-based, cost-effective and dependent on the project's requirement, also taking into account some financial involvement by the proposer. This will be decided on a case-to-case basis.

The Farm Innovation and Promotion Fund (FIPF) was created by NABARD to promote innovations in agriculture and other farm sector activities. The rate of interest for the soft loan will be on par with the bank rate or as applicable at the time

of sanction of the loan. The repayment period for the soft loan assistance will be a maximum of 7 years with a moratorium of 1-2 years as the case may depend on a case-to-case basis.

Besides this, institutions like Krishi Vigyan Kendras, Krishibhavans and various research institutions support the innovators on a regional basis. These institutions also assist in a proper way to finding the best source of financial assistance to further scale up the farmer innovations.Schemes from institutions like NABARD are implemented through various Non Government Organizations (NGOs) related to the rural sector.

Summary and conclusions

CHAPTER 5

SUMMARY AND CONCLUSION

Innovations are essential to agriculture since they set the stage for the industry's expansion and improvement. Agricultural machinery plays a crucial role in modern farming and ensures a stable food supply for the global population. Even though a field with great scope for investigation, the studies of farmer innovations in agricultural machinery with extension aspects are limited. In this drawback, the present study was conducted to know about multidimensional aspects of farmer innovations associated with agricultural machinery underlying the following objectives:

1. To document farmer innovations in the field of agricultural machinery
2. To evaluate the attributes of a few selected farmer innovations
3. To identify the constraints faced by the farmer during the phase of development of the innovations.

The study comprises three categories of respondents. The first category involves the 30 farmer innovators with innovative ideas and developed atleast one innovation in agriculture. The second category of respondents is the innovation facilitators. These people were associated with the farmer innovations and facilitated their development. A total of 30 innovation facilitators, one for each innovation, were chosen for the study. The third category of people is the respondents from the expert group for judging the listed innovations, who have related to various farmer innovation development were identified, which comprise researchers, extension workers, and progressive farmers.

Since the respondents were spread throughout the state, the whole state of Kerala was selected as the study area, and the respondents were selected using purposive sampling method. The independent variables were sorted out based on the judge's rating with expert extension professionals. Then an interview schedule had prepared, and data from the three categories of respondents were obtained. The data collected from the respondents were scored, tabulated, and analyzed using the appropriate statistical tools such as arithmetic mean (X), standard deviation (σ), percentage, correlation coefficient, chi-square test, Garret ranking, and index method.

In descriptive statistics, methods like frequency table, arithmetic mean, standard deviation and percentages were used to classify the innovations based on their origin, time taken for development and current stages. The same has been used to categorize innovators according to their profile characteristics. Chi-square test were used to study the relationship between innovation stages and the various attributes of innovation. It is also utilized to find the relationship between some farmer profile variables.

The attribute index for the innovations was calculated using the method adopted by (Aishwarya, 2016), which consists of eight dimensions, viz. relative advantage, observability, compatibility, complexity in design, complexity in use, discontinuity, communicability and trialability. The innovations were classified based on their overall attributes from these dimensions. The ranking of innovations carried out by the expert group based on these attributes has been analyzed by Kendall's coefficient of concordance. Various constraints faced by the innovators during the innovation development were analyzed using the Garret ranking method. Using Spearman's rank correlation method, it was found that there was a relationship between the independent variable and the dependent variable. Finally, the institutions that provided support for these innovations for their development have been documented.

5.1 Remarkable findings from the study of innovations:

5.1.1 Documentation of farmer innovations

- The cause for the evolution of the majority (50%) of these innovations was to solve the challenges faced by peers, followed by the problem faced by self (30%). 13.33 per cent of innovations were developed to innovate something new, whereas 6.67 per cent of innovations were made to meet the service necessity of the clients.
- A significant proportion (66.67%) of the innovations took two to seven years to develop, while 33.33 per cent of innovations took less than two years, and 10 per cent of innovations took more than seven years to develop.

- Approximately 63.33 per cent of the ideas had progressed to the commercialization stage, while 16.67 per cent had only progressed to the minimal viable product stage. Only 10% of innovations made it to the prototype and production stages each.

5.1.2 Farmer profile characteristics

- The majority of farmer innovators (46.67%) are older, while 43.33 per cent are middle-aged, and 10% are young. About 40 per cent of the respondents had graduation or diploma or ITI as the educational qualification, followed by 30 per cent of the innovators, each having high school and higher secondary level of education each.
- A major proportion of respondents, roughly 63.33 per cent, had little to no experience in farming, compared to 26.67 per cent of innovators, who have some experience. Few innovators have an extensive farming background (10%).
- A low level of industrial experience was held by 43.33 per cent of the innovators, followed by medium industrial experience (36.67%). Only 20 per cent of the farmers had strong industrial experience.
- More than half of farmer innovators (56.67 per cent) have an annual income of 2 lakhs to 5 lakhs, 40 per cent have a yearly income of more than five lakhs, and just one farmer (3.33%) has an annual income of less than 2 lakh.
- The majority of farmers (33.33%) make their living via farming and labour, whereas 30 per cent earn their income just through farming, 23.33 per cent earn their lives through farming and service, and 13.33 per cent earn their living through farming and business.
- More than half of the farmer innovators, i.e., 56.67 per cent, had medium innovativeness, while 26.67 per cent and 16.67 per cent of innovators showed low and high ranges of innovativeness, respectively.
- When choosing their knowledge sources, 36.67 per cent combined formal, informal, and mass media. Innovators who used both formal and informal sources accounted for 26.67 per cent of the total. 16.67 per cent of innovators relied only on formal sources, whereas 13.33 per cent relied primarily on

informal ones. Only 6.67 per cent of innovators relied on both formal and mass media simultaneously.

- The innovators with medium scientific orientation comprise the majority (76.67%), followed by 13.33 per cent having low scientific orientation and 10 per cent with high scientific orientation.
- The majority of innovators (83.33%) are capable of taking on medium levels of risk, with 10 per cent being capable of taking on high levels of risk and 6.67 per cent being capable of taking on low levels of risk.
- More than half of the farmer innovators (73.33%) fall into the medium extension contact group, while 13.33 per cent each fall into the low and high extension contact categories.
- About 70 per cent of the farmer innovators get in touch with supporting agencies like NIF, NABARD, KSCSTE..etc., to receive support for their innovation, while 20 per cent of them approach agricultural research institutions like ICAR, SAU, and KVKs to seek assistance. Only 6.67 per cent approaches the Department of Agriculture and Farmer's Welfare, and 3.33 per cent seeks technical institutions like NIT and IIT for support.
- Majority of innovators (76.67%) have a medium level of economic motivation, followed by innovators with low and high levels of economic drive (16.67% and 6.67%, respectively).
- More than half of innovators (73.33%) had medium self-confidence, with 16.67 per cent having high self-confidence and 10 per cent having low self-confidence.
- The majority of innovators (40%) relied on cooperative banks or societies to assist them with financing. 33.33 per cent of innovators invested their own money into the idea, whereas 20 per cent relied on private agencies or relatives. Only 6.67 per cent of farmers used nationalized banks as their source for getting finance.

5.2 Analysis of farmer profile characteristics

- Occupational status and prior farming experience had a sizable beneficial association. Majority of the farmer innovators (26.7%) who depends on farming and labour had little prior farming experience.

- The result shows a significant association between occupational status and industrial experience. A significant proportion (26.7%) of farmer innovators with solely farming as their occupation have little industrial experience.
- It is established that there is a link between industrial experience and the innovativeness of the innovators. About 26.7 per cent of farmer innovators with medium industry experience were moderately innovative.

5.3 Attributes of farmer innovations

- The majority (50%) of the cases that have been documented involve innovations with a medium relative advantage, followed by innovations with a high relative advantage (40%) and low relative advantage (10%). More than half of the innovations have medium observability (60%), followed by 23.33 per cent with high observability and 16.67 per cent with low observability. More than half of the innovations (60%) are highly compatible, with 40 per cent having medium compatibility and 10 per cent having low compatibility.
- Innovations with low complexity in use represent the majority (50%) of the total, followed by those with medium complexity in use (43.33%). A few innovations have a high level of complexity in their application (6.67%). A major proportion of the innovations (73.33%) have low design complexity, whereas 20 per cent have medium complexity and 6.67 per cent have high complexity in design.
- Low discontinuity innovations constitute the majority (56.67%), followed by medium discontinuity innovations (36.67%) and high discontinuity innovations (6.67%).
- The majorities (60%) have medium communicability, followed by 30 per cent who have high communicability and 10 per cent who have poor communicability.
- Innovations with high trialability make up the majority (66.67%), followed by innovations with medium trialability (26.67%) and poor trialability (2%).
- The major proportion (70%) of farmer innovations are connected with medium attributes, followed by high attributes (16.67%). A few innovations (13.33) are classified as having poor attributes.

5.5 Stages of innovation development

- The majority (33.3%) of innovations that have reached the commercialization stage have a high relative advantage. About 40 per cent of these innovations that have advanced to the commercialization stage exhibited medium observability.
- About 40 per cent of the ideas that had progressed to the commercialization stage demonstrated high compatibility. The majority (30%) of these ideas that had advanced to the commercialization stage had little complexity.
- Those innovations that had progressed to the minimal viable product stage had modest design complexity, i.e., about 50 per cent. A majority (33.3%) of innovations exhibited minimal discontinuity and managed to reach the commercialization stage.
- A considerable number (43.3%) of the ideas that had progressed to the commercialization stage demonstrated medium communicability. A significant portion (53.3%) of innovations that had progressed all the way to the commercialization stage of their development showed high trialability.

5.6 Factors affecting attributes of farmer innovations

- The relationship between the overall innovation attributes and some profile characteristics like educational status, annual income, industrial experience, institutional support, innovativeness, self-confidence, risk-bearing ability, and economic motivation were studied.
- Among farmer innovators, educational status, industrial experience, institutional support, innovativeness, and self-confidence showed a positive and significant relationship with the innovation attribute. At the same time, annual income, risk-bearing ability, and economic motivation had a negatively significant relationship.

5.7 Constraints in promoting farmer innovations

- The significant technical constraint in promoting farmer innovation is the lack of proper knowledge regarding further stages of innovation development, followed by a lack of expertise for validation.

- ❖ The major infrastructural constraint in promoting farmer innovation is the lack of testing facilities for innovation, followed by a lack of mass production centers.
- ❖ The lack of government financial support is the major economic constraint in promoting farmer innovation, followed by high consultancy and overhead costs.
- ❖ Work overload and engagement in other sectors, followed by political intervention, are the main administrative constraints to fostering farmer innovation.

5.8 Suggestions for improving farmer innovation development

Farmer innovators are facing various problems regarding several aspects of innovation development. Based on the constraints faced by the farmer innovators during their innovation development, various suggestions have been developed from the information obtained during the study. The major suggestions include the following:

- ❖ Setting up village-level resource centers for easily accessing innovation support and availing facilities for innovation development.
- ❖ Forming and assigning a team of innovation coordinators to look after the innovations developing on a regional basis.
- ❖ Providing more awareness and training programs at the village level regarding innovation supports, patenting, new technologies..etc.
- ❖ Increased access to markets for a faster spread of rural innovations in society.
- ❖ Encouraging public-private partnerships to support developing and implementing new technologies and practices.
- ❖ Encouraging collaboration and information sharing among farmer innovators.
- ❖ Timely availability of funds and support from the side of government.

Plate 1: Documentation of farmer innovations

Coconut dehusking machine

Automated rubber tapper

Tender coconut peeler

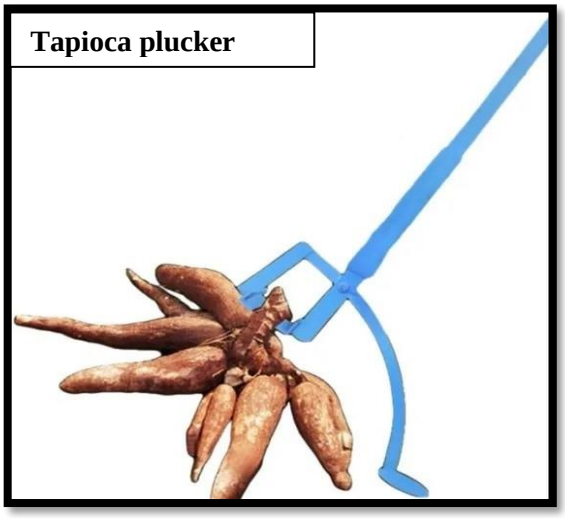
Poultry litter raking machine

Multipurpose wheelbarrow

Smart latex collector

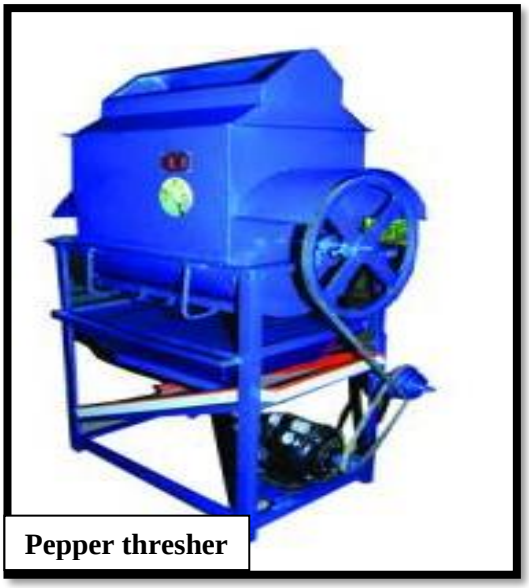
Plate 2: Documentation of farmer innovations

Wooden paddy thresher



Tapioca plucker

Arecanut dehusker



Pepper thresher

Climbing gear for trees

Hand operated arecanut peeler

Plate 3: Documentation of farmer innovations

Cardamom washing machine

Coconut dehusker with gear

Air cooler cum humidifier

Earth digger for farmers

Poultry mitra raking machine

Plate 4: Documentation of farmer innovations

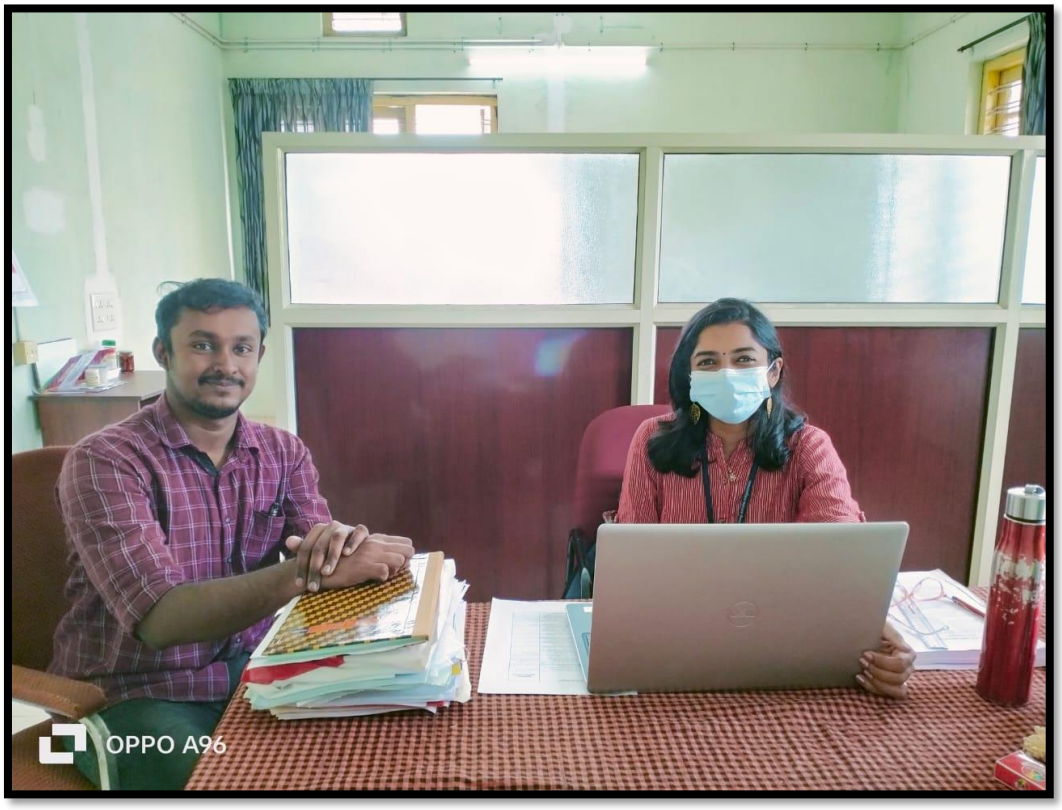
Polybag filling device

Wonder climber

Arrowroot powdering machine

Refined pepper thresher

Plate 5: Documentation of farmer innovations



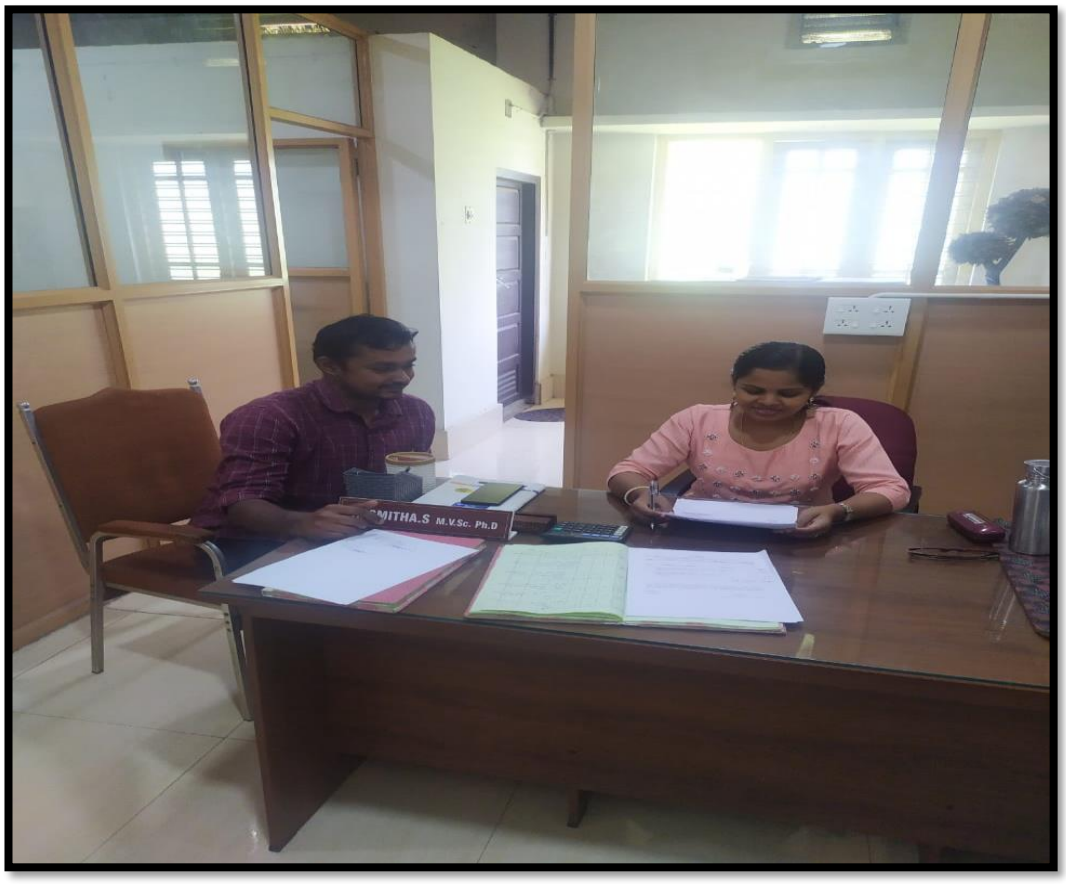


Plate 6: Analysis with innovation facilitators and expert group

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Appendices

APPENDIX-I

INTERVIEW SCHEDULE FOR FARMER INNOVATORS

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLANIKKARA, THRISSUR
DEPARTMENT OF AGRICULTURAL EXTENSION EDUCATION

'Farmer innovations in the field of agricultural machinery:
A multi-dimensional analysis'

I. Profile of farmer innovator

1. Name of the innovator:
2. Address:
3. Age of the innovator
4. Educational status:
   High school ☐
   Higher Secondary ☐
   Graduate/ITI/Diploma ☐
5. Farming experience (in years):
6. Industrial experience (in years):
7. Annual income (in Rs):
8. **Occupational status:**

Sl No:	Category	Occupation
1	Only farming	
2	Farming + labour	
3	Farming + service	
4	Farming + business	

9. Innovativeness

Please, state your opinion about the following statements

Sl No.	Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	I believe there are always new and better ways of doing things					
2	I like to keep up-to-date information about the subjects of my interest					
3	I would prefer to wait for others to try out new practices first					
4	I rarely trust new ideas until I can see whether the vast majority of people around me accept them.					
5	I feel that I am an influential member of my peer group.					

10. Extension Contact

Sl.no	Agents of support	Frequency of contact		
		Frequently	**Occasionally**	**Never**
1	KVKs			
2	SAUs			
3	Research Institutions			
4	Recognizing Institutions (PPVFRA, NIF etc.)			
5	NGOs			
6	Others			

11. Institutional Support

Please (✓) mark the institution from which you were assisted for your innovation

- Agricultural research institutions (ICAR, SAU, KVK) ☐
- Department of Agriculture and Farmer's Welfare ☐
- Technical Institutions (NIT, IIT...etc.) ☐
- Other supporting agencies (NIF, NABARD, KSCSCTE...etc.) ☐

12. Information-seeking behavior

Please state the sources you have utilized for getting farm information and the degree of contact with them.

Sl No.	Information sources	Please (✓) mark where applicable
1	Formal sources	
2	Informal sources	
3	Formal+informal+mass media	
4	Formal+informal	
5	Formal+mass media	

13. Self-confidence

Please, state your opinion about the following statements

Sl. No.	Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I feel no obstacle can stop me from achieving my final goal				
2	I am generally confident of my own ability				
3	I am bothered by inferiority feelings				
4	I do not have initiative				
5	I get discouraged easily				

14. Scientific orientation

Please, state your opinion about the following statements

Sl.No.	Statement	Agree	Undecided	Disagree
1	New agricultural machinery innovations give better results to farmers than the traditional one			
2	Even a farmer with lot of experience should use new innovations for improving his standards			
3	Though it takes time for a farmer to familiarise the working of machinery it is worth the efforts			
4	A good farmer experiments with new innovations in farming			
5	Traditional farming machineries have to be changed in order to raise the standard of living of a farmer			

15. Risk bearing ability

Please, state your opinion about the following statements

Sl. No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	An innovator should focus two or three areas to avoid greater risks				
2	It is good for an innovator to take risk when he/she know her chance of success is fairly high				
3	It is better for an innovator not to try new methods unless most others have used them with success				
4	Trying an entirely new methods in business by an innovator involves risk, but it is worth				

16. Economic motivation

Please, state your opinion about the following statements

Sl. No.	Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1	A farmer-innovator should work towards larger yields and economic returns from his innovation				

2	The most successful innovator is the one who makes the most profit				
3	An innovator should try any new idea which may earn him more income				
4	It is difficult for the farmer's children to make a good start unless he provides them with economic assistance.				
5	A farmer must earn his living, but the most important thing in life cannot be defined in economic terms				

17. Sources of finance

Sl.No	**Source**	**Please (✓) mark where applicable**
1	Nationalized banks	
2	Cooperative banks/ Societies	
3	Private agencies /Relatives	
4	Own investment	

II. Documentation of farmer innovations

1. Name of the innovation:
2. The problem for which the innovation was developed as a solution:
3. Time taken for innovation development:
4. Major details about the innovation with its specifications:
5. Reason behind the development of the innovation?:

a) To solve the problem faced by self

b) To innovate something new

c) To solve problems faced by peers

d) To satisfy the service requirement of customers

6. Present stage of development of the innovation:

Sl. No.	**Stages of innovation**	**Please (✓) mark where applicable**
1.	Proof of concept (POC)/Ideation stage	
2.	Prototype stage	
3.	Pilot/Minimum Viable Product (MVP) stage	
4.	Production stage	
5.	Commercialization stage	

7. What efforts have you made to scale up the innovation?
   a. Linking with industry
   b. Starting publicity through media
   c. Arranging demonstrations in front of innovative farmers
   d. Making liaisons with government departments
   e. Starting my own industry
   f. Starting an online platform for selling
   g. Others
8. What are your suggestions to accelerate the innovation development process?

9. Constraints faced by the farmer innovators during the innovation development

Constraint Type	Sl. No.	Problems Faced	Rank
Technical Constraints	**1**	Lack of knowledge	
	2	Lack of expertise for validation	
	3	Lack of separate staff	
	4	Lack of design support for development	
	5	Location specificity of the innovations	
	6	Scouting and identification problem	
Infrastructural Constraints	**1**	Lack of testing facilities for innovation	
	2	Lack of mass production centers	
	3	Lack of proper marketing infrastructure	
	4	Lack of incubation centers	
	5	Lack of research support	
	6	Lack of transportation facilities	
Economic Constraints	**1**	Lack of financial support from the Government	
	2	High consultancy and overhead cost	
	3	Non-availability of commercializing partners	
	4	Disagreement in sharing of benefits of innovator and organization	
	5	High input cost at purchase	
	6	No insurance coverage	
Administrative Constraints	**1**	Work overload and involvement in other sectors	
	2	Political interference	
	3	Lack of networking between organizations	
	4	No standard set of indicators for validation	
	5	Job insecurity of temporary workers	
	6	IPR protection and related issues	

APPENDIX-II

INTERVIEW SCHEDULE FOR INNOVATION FACILITATORS

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLANIKKARA, THRISSUR
DEPARTMENT OF AGRICULTURAL EXTENSION EDUCATION

'Farmer innovations in the field of agricultural machinery:
A multi-dimensional analysis'

Analysis of perceived attributes by innovation facilitators

1. Name of the facilitator:
2. Address:
3. Years of experience in working with farmer innovations:
4. Perceived attributes of the farmer innovation:

   Please, state your opinion about the following statements

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Relative advantage 1. This machine saves potential adopters time in use. 2. This machine allows potential adopters to reduce costs 3. This machine is better over the existing machines in its functions				
2. Observability 1. I can observe this machine being used by others				

2. I can easily observe the working mechanism of the machine 3. The output from the use of the machine is clearly visible.				
3. Compatibility 1. This machine compliments other machines currently owned by the potential adopter 2. Using this machine is compatible with the existing socio-cultural background. 3. The machine is compatible with the present skills of the farmer				
4. Complexity in use 1. This machine takes a considerable amount of time to learn how to use 2. Special skills are required for installation/assembly 3. The machine can be used without any gender bias.				
5. Complexity in design 1. This is considered a high-technology machine 2. This machine is mechanically and technically complex 3. The operator's manual is lengthy for this machine				

6. Discontinuity 1. This machine contains a new, cutting-edge technology 2. This machine is new to the world or industry 3. This machine provides radically new machine benefits or features				
7. Communicability 1. This machine would be easy to describe in an advertisement 2. It would be easy to describe this machine to others 3. Users of this machine can easily communicate about the machine with other members of the society				
8. Trialability 1. This machine can be tested with/without making a purchase commitment 2. This machine can be tried before the purchase 3. Demonstration of the machine can be easily arranged				

APPENDIX-III

INTERVIEW SCHEDULE FOR EXPERT GROUP

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLANIKKARA, THRISSUR
DEPARTMENT OF AGRICULTURAL EXTENSION EDUCATION

'Farmer innovations in the field of agricultural machinery:
A multi-dimensional analysis'

1. Questionnaire for scoring perceived attributes by the expert group

Farmer ☐
Researcher ☐
Extension worker ☐

Please mark your response against the corresponding statements

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
	4	3	2	1
1. Relative advantage 1. This machine can save potential adopters time in use. 2. This machine allows potential adopters to reduce costs 3. This machine is better over the existing machines in its functions				
2. Observability 1. I can observe this machine being used by others 2. I can easily observe the working mechanism of the machine				

3. The output from the use of the machine is clearly visible.				
3. Compatibility 1. This machine compliments other machines currently owned by the potential adopter 2. Using this machine is compatible with the existing socio-cultural background. 3. The machine is compatible with the present skills of the farmer				
4. Complexity-in-use 1. This machine takes a considerable amount of time to learn how to use 2. Special skills are required for installation/assembly 3. The machine can be used without any gender bias.				
5. Complexity-in-design 1. This is considered a high-technology machine 2. This machine is mechanically and technically complex 3. The operator's manual is lengthy for this machine				
6. Discontinuity 1. This machine contains a new, cutting-edge technology 2. This machine is new to the world or industry				

3. This machine provides radically new machine benefits or features				
7. Communicability 1. This machine would be easy to describe in an advertisement 2. It would be easy to describe this machine to others 3. Users of this machine can easily communicate about the machine with other members of the society				
8. Trialability 1. This machine can be tested with/without making a purchase commitment 2. This machine can be tried before the purchase 3. Demonstration of the machine can be easily arranged				

APPENDIX IV (A): INTRODUCTORY LETTER TO JUDGES FOR JUDGES RATING

KERALA AGRICULTURAL UNIVERSITY

Communication Centre, Mannuthy - 680651

Phone: 0487 2370773
email: ccmannuthy@kau.in

Dr. Sunil V.G
Assistant Professor
Communication Centre, Mannuthy
Major Advisor

Vellanikkara
25-05-2022

Dear Sir / Madam,

I would like to bring to your kind notice that **Mr. Jaizen Kuriakose (2020-11-075**) is undertaking a research study as a part of his Post Graduate program entitled **'Farmer innovations in the field of agricultural machinery: A multi-dimensional analysis'** under my guidance. The main objectives of his study are to **document farmer innovations in the field of agricultural machinery, evaluation of the attributes of a few selected farmer innovations and identification of the constraints faced by the farmer during the phase of development of the innovations.**

Considering your vast knowledge and experience, we request you to be a judge for rating the relevancy of the variables enlisted in the enclosed appendix. I request you to indicate the appropriate relevance of variables listed in the study by marking a **(✓)** in the relevant column. You can also suggest variables that you feel important for the study and also rate them under the appropriate column. I would like to request you to spare a little of your valuable time to go through them and rate them according to their relevance so as to formulate the final questionnaire.

Thanking you,

Yours faithfully,

Sd/-
Sunil V.G.

APPENDIX IV (B): LIST OF INDEPENDENT VARIABLES FOR JUDGES RATING

Title of the study

'Farmer innovations in the field of agricultural machinery: A multi-dimensional analysis'

Main objectives

- Document farmer innovations in the field of agricultural machinery
- Evaluation of the attributes of a few selected farmer innovations
- Identification of the constraints faced by the farmer during the phase of development of the innovations

Independent variables

The following independent variables are identified for the study based on the available literatures. Please (✓) mark the relevancy of the variables according to the scores mentioned below:

5=Very relevant, 4= Relevant, 3=Moderately Relevant, 2=Slightly Relevant, 1=Not Relevant

Sl. No.	Variables	5	4	3	2	1
1	**Age**: chronological years completed by the respondent at the time of the investigation					
2	**Educational status**: refers to the years of formal education the respondent underwent					
3	**Family type**: refers to whether all family members of the respondents are living together or separately					
4	**Farming experience**: refers to the number of years an individual had experience in farming and allied activities at the time of data collection					
5	**Industrial experience**: refers to years a respondent had spent and knowledge gained from working in a particular industry or sector of the economy					

6	**Occupational status**: refers to the work done by the farmer innovator to earn a livelihood					
7	**Social participation**: refers to the non-involvement or involvement of the respondent in any social organization, either as a member or as an office bearer					
8	**Extension contact:** it is referred to the extent of contact with various institutions and agencies by the farmer during the innovation development					
9	**Area of residence:** refers to the type of place the farmer belongs to					
10	**Institutional support:** refers to the support received from various institutions to the innovators during his entire course of development of the innovation					
11	**Land holding size**: defined as the extent of land an individual possessed and cultivated is termed as land holding					
12	**Annual income:** it is the total income in rupees obtained by the respondent's family from different sources like crops, animal husbandry enterprises, salary, wages, business, and other sources in a year					
13	**Innovativeness:** defined as the individual interest in finding and trying out new things					
14	**Information-seeking behavior:** it refers to the frequency of contact of farmers with various sources of information					
15	**Sex**: It is defined as the biological difference between men and women, which is universal and determined at the time of birth					

16	**Scientific orientation**: defined as the degree of orientation of the respondents towards the use of scientific methods in agriculture					
17	**Achievement motivation**: defined as the desire to achieve a feeling of individual accomplishment					
18	**Creativity**: defined as the tendency to generate or recognize ideas, alternatives or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others					
19	**Risk bearing ability**: defined as the degree to which the respondent is oriented towards risk and uncertainty and has the courage to face the problem					
20	**Scientiscism**: It is the belief held by the farmer that human situations must be according to the rules laid down in exact science for performing observations and testing the soundness of conclusions					
21	**Material Possession:** refers to the number of farm machinery/implements possessed by the farmer					
22	**Decision-making ability**: defined as the means used by the farmers to decide on their farm activities					
23	**Leadership ability**: characterized as how much an individual leads and directs the subordinates or laborers in various activities on the farm					
24	**Cosmopoliteness**: defined as the contact of the individual with the outer world.					
25	**Self confidence**: refers to the belief of the respondent farmers in their abilities, initiative, and zeal to achieve their goals or aim					
26	**Economic motivation:** refers to occupational success in terms of profit maximization and the relative values individuals place on economic ends					

27	**Market orientation**: refers to the extent to which firms use information about their stakeholders to coordinate and implement strategic actions					
28	**Source of finance:** corresponds to the various financial agencies that the innovator has been approached for accessing credit or loans for upscaling his innovation.					
29	**Others (Please specify)**					

Suggestions and recommendations

APPENDIX V: INDEPENDENT VARIABLES AND THEIR MEAN RELEVANCY SCORES-JUDGES RATING RESULTS (DESCENDING ORDER)

Sl. No.	Variables	Mean relevancy scores obtained on judges rating
1	Extension contact	4.62
2	Innovativeness	4.53
3	Self-confidence	4.48
4	Information seeking behavior	4.42
5	Industrial experience	4.37
6	Scientific orientation	4.32
7	Economic motivation	4.26
8	Institutional support	4.21
9	Farming experience	4.18
10	Educational status	4.12
11	Risk-bearing ability	4.09
12	Occupational status	4.05
13	Sources of finance	4.03
14	Annual income	3.93
15	Age	3.87
16	Social participation	3.82
17	Creativity	3.71
18	Material Possession	3.67
19	Decision-making ability	3.63
20	Leadership ability	3.58
21	Cosmopoliteness	3.53
22	Market orientation	3.48
23	Achievement motivation	3.41
24	Sex	3.36

25	Land holding size	3.29
26	Family type	3.17
27	Scientiscism	3.12
28	Area of Residence	3.09

FARMER INNOVATIONS IN THE FIELD OF AGRICULTURAL MACHINERY: A MULTI-DIMENSIONAL ANALYSIS

By

JAIZEN KURIAKOSE

(2020-11-075)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE IN AGRICULTURE

(AGRICULTURAL EXTENSION EDUCATION)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

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KERALA, INDIA

2023

ABSTRACT

Innovation is one of the most fundamental elements for enhancing the agricultural production and productivity, which includes farmer innovations too. Agricultural machinery plays a crucial role in modern farming and ensures a stable food supply for the global population. Even though a field with great scope for investigation, the studies of farmer innovations in agricultural machinery with extension aspects are limited. In this drawback, the present study was conducted to know about multidimensional aspects of farmer innovations associated with agricultural machinery.

The current study entitled "Farmer innovations in the field of agricultural machinery: A multi-dimensional analysis" was conducted at Kerala Agricultural University. Data were collected among 30 farmer innovators, 30 innovation facilitators and 30 experts from the category of research scientists, extension officials and progressive farmers. The respondents were selected from different parts of Kerala state based on the purposive sampling method. An interview schedule was prepared to collect data from the respondents.

The study results from the documentation revealed that among the farmer innovations, the reason for the evolution of majority (50%) of innovations was due to the problem faced by peers and nearly 37 per cent of these innovations had institutional support from Kerala State Council for Science, Technology and Environment (KSCSTE). The innovations also received support from institutions like Kerala Agricultural University-Agribusiness Incubator (KAU ABI), National Institute of Technology (NIT), National Innovation Foundation (NIF) and National Bank for Agriculture and Rural Development (NABARD) in their developmental stages. Majority (63.33%) of these documented innovations had reached the commercialization stage of the innovation development process.

A large proportion of the farmer innovators, 46.67 per cent, belongs to the old age category with an age of 51 years and above and 40 per cent of them had an education level of either graduation, diploma or ITI. A majority (63.33%) of them had low farming experience and 43.33 per cent with low industrial experience. Almost 56.67 per cent of the farmer innovators had an annual income in the range of Rs/- 2,00,000 -5,00,000,

whereas 33.33 per cent of them had farming and labor as their primary occupation. Approximately 56.67 per cent of them had a medium level of innovativeness and about 36.67 per cent of them had chosen a combination of formal sources, informal sources and mass media for seeking information. A majority (76.67%) of them had a medium level of scientific orientation and 83.33 per cent had medium risk-bearing ability. In the case of extension contact, majority (73.33%) of the farmer innovators belonged to the medium category and nearly 76.67 per cent of the farmer innovators had a medium level of economic motivation. About 73.33 per cent of them had a medium level of self-confidence.

The analysis of farmer profile characteristics was carried out using two-way contingency table and chi-square test. The results inferred that there exists a positive significant relationship between occupational status and farming experience; occupational status and industrial experience; innovativeness and industrial experience. The perceived attributes of farmer innovation include eight dimensions, i.e., relative advantage, observability, compatibility, complexity in design, complexity in use, discontinuity, communicability and trialability. The overall attribute score shows that the majority (70%) of innovations belonged to the medium category. An analysis of the attributes with stages of innovation development was carried out using two-way contingency table and chi-square test, and results inferred that there exists a positive significant relationship between attributes and stages of innovation.

The relationship of independent variables with the dependent variable was analyzed using Spearman's rank correlation coefficient method. The independent variables like educational status, annual income, institutional support, innovativeness, industrial experience and self-confidence shows a positive significant relationship. In contrast, risk-bearing ability and economic motivation show a negative significant relationship with the attributes of innovations. Using Kendall's coefficient of concordance, the ranking of innovations was carried out from the responses of the expert group. The primary constraints faced by farmer innovators were; a lack of proper knowledge regarding further stages of innovation development, lack of testing facilities for innovation, lack of financial support from the government and the work overload of the associated officials.