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SUSTAINABLE TECHNOLOGIES AND GOOD EXTENSION PRACTICES FOR SMART AGRICULTURE IN NAGPUR AND AMRAVATI DISTRICTS OF MAHARASHTRA STATE

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ABSTRACT:

Agriculture plays a main role to keep the environment stable. As most of the countries depend on agriculture for their economic growth and reduction in hunger and poverty. Agriculture faces serious difficulties in the coming decades. To secure long-term food security, food systems are evolving. According to new research, the effects of changing climate on agriculture systems and food systems may be more widespread than previously thought. Technology and science both play a very significant role in shaping the agricultural sector and growth of developing countries. Due to the advancements in every sector, an innovative technological boost is also needed for the traditional farming sector. Smart farming entails incorporating innovative concepts and technology into agricultural equipment, machinery, units and sensors for use in production systems. Due to the poor reach of all these technological solutions and lack of awareness, some region-wise extension practices should be identified to serve all the important updates to the farmer level. Hence the idea of this study is to quantify the problems of the farmers in the field and to make a sustainable technological solution for them. The aim was to characterize some best extension services among the farmers and to elicit the constraints regarding dissemination of extension. By identifying various difficulties of farmers, various extension practices, as well as some technological solutions, are recommended as sustainable adaptation strategies which will help to meet the future food requirements and cope with the future climate consequences.

Key words: - Agriculture, Climate Change, Extension, Sustainable, Smart Agriculture, Technologies

INTRODUCTION:

Agriculture has a critical part in maintaining environmental stability. It plays a vital role in most countries' economic growth and poverty alleviation; thus, they rely on it heavily. Due to advancements in every industry, the traditional farming sector, too, demands a technological boost. Smart farming (SF) is the process of incorporating novel concepts and technology into various agricultural equipment for use in agricultural production systems. Farmers found it challenging to understand modern farming techniques due to advances in machinery and online smart information systems. As a result, this study has two objectives: i) To define what constitutes good agricultural extension services ii) To identify the challenges that farmers face in the field and develop long-term technology solutions for them. Agricultural extension is one of the crucial pillars of advancement in village communities and also a component of an agricultural development plan aimed at refining the sustainability of agricultural systems, stimulating agronomic diversification, and bringing farmers into new dynamic markets. These extension services have been concerned with sharing research observations and modified farming techniques for smallholder farmers all over the world (Kabir & Roy, 2015).

Agriculture extension has a long history in India. The agricultural extension was mostly the responsibility of state agriculture departments in the post-independence era. Farmers need extension services for boosting their farming

productivity by sharing information designed at improving the farmers' attitude, knowledge and abilities. Agricultural development in many developing nations is dependent on extension services, which assist farmers in identifying, analysing, and connecting with research on local production difficulties. They also raise awareness about ways to improve farm yields, resulting in higher revenue and a better standard of living (Van den ban *et al*, 1996).

Agricultural knowledge transfer as a system strives to disseminate skills and information among farmers, researchers and extensionists to aid in the identification of farming issues. This is performed through on-the-spot coaching with individual farmers; guidance and help on technical agriculture acquaintance and processes while taking into account the individual's and group's economic and social circumstances. In a word, extension is an instructional process that employs a variety of approaches to assist farmers in improving their level of life. Similar extension strategies could be used to figure out how to best deal with farmers to suit their needs. Traditionally, an extension has emphasised farmer training, increased output, and technology transfer. Today's definition of the extension includes more than just technology transfer; it also includes learning and assisting farmers in self-help; to put it another way, it entails supporting farmers in thinking about how to think rather than what to think.

The absence of technical human resources is the most serious problem with the extension system. In India, a huge number of positions in the public extension system remain unfilled, causing extension employees to overwork and reduce their effectiveness (Mukherjee and Maity, 2015). To ensure that global developments benefit smallholder and marginal farmers, a new framework to enable innovation development and dissemination is required to strengthen how information, knowledge, and technology are developed and shared. Smallholders and marginal farmers (farms of less than 2 hectares) continue to use conventional farming techniques, resulting in lower yields year after year (Tikadar and Kamble, 2021).

Smart farming tools provide many advanced innovation technologies like robotics, AI, area mapping & geological technologies, policymaking, and statistical approach and procedures to agriculture. Advances in tools, mechanical parts, software-controlled devices, drones and sensors, data analysis and global positioning technologies are among the most potential smart farming technologies, although their development and diffusion may take time and money.

Increasing agricultural production is the ultimate goal of both research and extension systems. Their roles in developing and disseminating technology are mutually beneficial. To develop research agendas and set priorities, research institutions need knowledge on the challenges, technology needs, ecological and socio-economic environments for producers. Forming a study around the needs of producers results in technology that is more user-friendly, as well as research institutes spending their capital more resourcefully. Because the research focuses mostly on the practice of disseminating technology and ideas. This aids in the comprehension of effective agricultural extension methods that can assist smallholders and marginals in obtaining improved ideas in increasing their agricultural productivity.

These local demands in India are inextricably related to the massive changes in agriculture that are taking place. Market liberalisation and wealth accumulation are fast-changing traditional staple food-based sustenance systems into admired, informational-intensive businesses (Adhiguru *et al.*, 2009). Today, farmers use a variety of information sources to tap into marketplaces and supply high-quality products to consumers. As Adhiguru *et al.* (2009) point out, the information

required in this context is demand-driven. For their information needs, Indian farmers have access to accessible extension sources. Access to information improves as the size of the farm grows. The utmost essential knowledge sources and advice for extension are progressive farmers, input merchants, and the media. A minor part is played by output processors/buyers and public extension workers. Demonstration by government organisations, village farming fairs, farmers' study tours, and Krishi Vigyan Kendras (Farm Science Centres), all are of little relevance to smallholders. For all farmers, the private sector i.e., progressive farmers and input dealers are a more vital source of funding than the govt. or public sector. Non-Governmental Organizations have a limited reach, in addition, they tend to favour larger farmers.

The value of various sources changes depending on the information sought. Farmers are mostly interested in seed, fertiliser, crop protection, and harvesting/marketing information when it comes to cultivation. Health and nutrition are the most important aspects of animal husbandry. Extension staff, input dealers and progressive farmers are all key sources of seed information. When it comes to livestock fodder and fertiliser; private input dealers are the most commonly contacted. Crop protection information can be found mostly in newspapers and on the radio. Progressive farmers and newspapers are the key sources of harvesting/marketing information. The data suggests that there is some diversity in Indian extension. However, just approximately 40% of farmers have access to improved technical information, which is concerning. Although the govt./public sector is there, smallholders' access to its services appears limited. Extension services must be enhanced and motivated in light of the changing climate in the agriculture sector so that they can assist rural farmers in developing sustainable agriculture.

Role of Extension in Rural Development

Agri advisory services, are critical for increasing agricultural production, ensuring food security, improving rural livelihoods and encouraging sustainable agriculture as a source of poor economic development. The extension helps pastoral producers and farmers face and overcome new challenges in agriculture, such as the growing status of standards, tags, and food safety, progress in non-farm rural service and agricultural business, constrictions levied by health challenges that affect rustic livelihoods, natural resource degradation and climate change (Bachhav et al, 2012).

In terms of crop and livestock productivity, an extension may primarily help with two components: agricultural transformation and land improvement. Extensionists have the potential to make a significant contribution to rural development if they are guided by specific policies. The research discovered a few key areas where the extension can help.

Food security:-

As per Rivera and Qamar (2003), the availability, accessibility, and consumption of food are all aspects of food security. Food availability can be defined as having adequate amounts of food available to all people of a country at all times. Food can be obtained through domestic production, other household outputs, commercial imports, and food assistance. Sustainable food security and poverty-reduction programmes enable rural populations to grow and make alternate products to improve their quality of life.

Natural resource conservation:

Smallholder, marginal farmers and communities receive only sporadic backing for resource conservation unless legislation makes it compulsory. The best illustration is the start of the land reform and soil nutrient control programme. True extensionists do not employ coercion but use recognised persuasion tactics to

help farming communities protect natural resources.

Valuable information dissemination:

Farmers are frequently persuaded to embrace new techniques by extensionists since they have access to research and its findings. They usually acquire adequate training or workshop that they may use to assist farmer communities. Farmers needs a variety of information from extensionists in case of production, well cultural practices and marketing strategies.

Rural agricultural empowerment group:

The goals for the rural agricultural empowerment group are a) Growth in regional level income generation, b) Job creation, and c) enhancement in income circulation within the local geographical location

Farmers' need for extension:

Agri extension must be able to respond to the changing needs of a dynamic agriculture system. Farmers have efficiently transitioned from subsistence to commercial agriculture, and as a result, they now create a large marketable surplus.

The landholding size of farmers are gradually shrinking, which can make commercial production impracticable. The issue requires a new approach in the farming sector and the formation of new farmer producer organisations or groups, either as businesses or associations.

Everybody knew that agricultural households had various amounts of land, labour, crops and other resources throughout this time. Agricultural research and extension systems, on the other hand, were primarily focused on boosting agricultural productivity to attain the food security of the nation. Nevertheless, the global food ecosystem is becoming more linked, and the global food prices are reflecting and it fluctuating demand and supply for all sorts of food materials, as well as agricultural goods sold by Farmers' Organizations and Agripreneurs. As a result, new products such as green fuel and changing climate can cause significant price changes in many food products.

This can be the reason why the extension advisory services are shifting for the improvement of rural farming communities for achieving the food security targets of the households by improving farmers' ability to cope with the market changes more quickly. It is because the farm households' managerial, practical and socioeconomic capabilities and information demands vary by country and culture (Singh *et al*, 2006).

Role of social media in Agricultural Extension and Advisory System

Farmers demand a combination of innovations and facilities, as well as constant access to information and expertise, in a rapidly changing environment. All of this having under one roof in a pastoral location may considerably speed up innovation uptake and improve farmer advantages. In recent years, the use of social media platforms gains their popularity in agriculture and extension, few well-known platforms such as Facebook, Twitter, and YouTube platforms are use farming extension services (Suchiradipta *et al*, 2018).

MATERIALS AND METHODS

Nagpur and Amravati were chosen from the two Maharashtra districts based on different climate change agriculture reports that predict the forthcoming major climate change affecting districts in the future, as well as the fact that the Vidarbha region reported the highest rate of farmer suicides. The districts were also chosen based on the number of successful agripreneurs, private, public, and civil organisations in the area, including NGOs and farmers' organisations. Few major successful farmers or agripreauners and master or leader farmers of both the districts were chosen and sampled to find the good agricultural extension practices of that region. An interview schedule was used to collect qualitative and quantitative data.

Primary data was collected by provoking information from these farmers through a specially designed and developed questionnaire that focused on climate change perceptions, impacts assessment during sowing, crop growth, post-harvest, livestock, and adaptation strategies currently in use and planned for the future. To obtain quantitative and comparable responses, a Likert scale was utilised for the responses to the questions. SPSS and Origin-pro were used to analyse the gathered data. Secondary data was acquired from government databases such as the Census of India, KVK's, and the India Meteorological Department, and included study area, climate, rainfall, demographic profile, and so on. A total of 200 farmers were selected as a sample size. 100 farmers from each district i.e., 50 beneficial farmers and 50 non-beneficial farmers were chosen using snowball sampling technique and random sampling technique for the study.

Study Area

Nagpur district is located in Maharashtra's Vidarbha region of central India. Nagpur is the administrative capital of the district and the 13th most populous city in India. Nagpur district is Maharashtra state's third-largest city and the winter capital of India. Agriculture, like agriculture in most other parts of India, plays an important role in Nagpur's economy. Cotton, sugarcane, soyabean, pulses, wheat, jowar, bajra, linseed, groundnut, sunflower, tur, and many others are among the most widely produced crops in Nagpur. In 2011, the Nagpur district had a population of 4,653,171 people, almost the same as Ireland or the US state of South Carolina. The district has a sex ratio of females 948 for males 1000 and an 89.52 per cent literacy rate. As of 2011, the district had a population of 4,653,171, with 64.26 per cent of the inhabitants living in cities. When the cropped area in Nagpur was increased, it gave the industry a much-needed boost. The decline in the number of fallow fields was the cause of this. Another factor was the growth in the amount of arable land. Orange, a delicious and sweet citrus fruit, is grown extensively in Nagpur's plantations. Nagpur's most important cash crops are soya beans and cotton.

Amravati is a district in Maharashtra, India's central state. The district covers a total size of 12,235 square kilometres. Amravati is situated between $20^{0}32$ and $21^{0}46$ north latitude and $76^{0}37$ and $78^{0}27$ east longitudes, with altitude 300 to 900 metres above mean sea level. The overall geographical area of the district is 12212 square kilometres or 3.96 per cent of the state's total area. There are 14 tehsils in the district (blocks). There are two tribal blocks in the district. Dharani and Chikhaldara are the two main characters. Amravati district has a population of 2,887,826 people, which is roughly the same as the country of Jamaica or the state of Arkansas in the United States, according to the 2011 census. The sex ratio in Amravati is 947 females for every 1000 males, with an 88.23% literacy rate. In the district, rainfed agriculture covers 91.50 per cent of the land. The entire area under Kharif crops is 683700 ha, with rabbi crops covering 106200 ha. Irrigation covers 80543 acres or 8.5 per cent of the total cultivated land in the area. Cotton is the principal cash crop in the district, with 327901 hectares under cultivation (34.60 per cent of total cropped area). The economy of the district is primarily based on agricultural production. Several cotton ginning and pressing operations, as well as oil mills and dal mills, are also present in the district.

RESULT & DISCUSSION:

To tackle the dilemma of shifting climatic regimes, Dubey et al. (2011) emphasised the necessity to revamp crop improvement and related crop management practices. Furthermore, farmer participation in research and extension is not ruled out for assessing,

validating, and disseminating location-specific pulse production technology.

Climate change is anticipated to have an impact on the local region's agricultural productivity. On agricultural lands, however, implementing sustainable agricultural techniques with the support of competent extension methods can mitigate much of the effects. As a result of the consequences of climate change and lack of farming-related expertise, the current investigation showed a slew of issues. The detected problems from the observed region are listed in table 1.

Soil fertility is affected by climate change, pest resistance is favoured, and the number of cotton production inputs consumed per unit of land increases (Soviadan et al., 2019). These findings are in line with the findings of this inquiry. Adaptive measures such as planting schedule tweaks and more sensitive cultivars could enhance agricultural production in India even more (Hebbar et al., 2013).

Water-saving irrigation systems can help agriculture adapt to the arid climate. To conserve water resources and ensure agricultural production stability, it is vital to minimise the time it takes for farmers to deploy such technology (Mi et al., 2021).

Farmers and scholars have made the following recommendations.

- **Enhancement in earlier extension Methods**

According to the findings and debate, the traditional extension means such as Kisan call centres, radio, and farm field schools are currently ineffective, as more than half of the respondents do not use traditional extension sources. As a result, some useful extension methods should improve or adjust these.

- **Extension workers training for skill up-gradation in the field of agricultural marketing**.

A robust system of marketing dissemination service is desperately needed for the village/block/district level to efficiently guide farmers on numerous aspects of marketing information, safeguarding market for farmers, guidance on upgraded market practises, and instruction on post-harvest management practises, in addition to improvements in traditional extension methods. Marketing Extension Linkage must be established by combining the existing extension network with the agriculture department. To carry out extension work successfully and efficiently, officers from the departments of horticulture, agriculture and agricultural marketing should be trained in all aspects of agricultural marketing. This will go a long way toward reducing post-harvest losses. Farmers' communication skills will be improved.

- **Social media platform implementation for good agricultural extension**

Extension professionals now have a new option to share diverse types of knowledge and to participate in discussions and dialogues about extension through social media. It also allows them to stay informed about recent advancements in the agricultural business. They can also reach out to a growing number of farmers using platforms such as Telegram, WhatsApp, Facebook, Instagram and YouTube.

Some new technological solutions are also invented which will help farmers to cope with climate change effects. The details of the technologies are mentioned below:

Sustainable Technologies Suggested for Farmers:

1. **Agri-Seeder**- A sustainable way towards placing the seeds

Many times actual yield comes out to be less than the expected yield. Reasons can be various, but one of them includes improper placement of the seeds. Agri seeder is an innovative seed placement machine that helps the farmer to place their crop seeds in their farm very precisely. It works while rotating the plough hooks dig out the

soil. Gradually the seed falls into the dugout hole due to the centrifugal force acting over it. The chain behind pulls the soil over the seed.

The drawback of Traditional seed placer:

Due to the displacement of the seeds, the actual yield of crops comes out to be less than the expected yield. This is because the seeds either do not get germinated properly or they become food to predators. The seeds also do not get proper nourishment. All these are because of the traditional methods used for placing or sowing seeds.

Purpose:

The main purpose of the agri-seeder is to place the seeds at Appropriate distance, Appropriate depth, in appropriate numbers, and thus to get a high yield

Advantages

i) Economical ii) Reduced seed costs iii) Greater crop uniformity iv) Equally spaced seeds v) High quality produce vi) Greater yield vii) Reduction in predatorying.

2. Multilayer poultry cage (pre-fabricated)

Agriculture plays a major role in reducing the hunger and poverty of the increasing population. Due to the increasing populations, and generation to generation shift from father to sons/Daughters, the agricultural lands are divided and become small. These changes make the farmers marginal (Land below 1 Hectare). Multilayer poultry cage is the innovative solution to make the marginal farmers more benefited at less space. Multilayer poultry cage is a triple-layered multi farming system used for agriculture.

Advantages:

i) Economical and materials are easily available, ii) Farmers get more benefit than Traditional system, iii) Waste generated from the system can be utilized up to 100%,

iv) Any size of this farming system can be possible according to land availability, v) Urban terrace farming is also possible with this system, vi) A limited size of this system is moveable

vii) Very low maintenance

3. No-tillage with direct seeding

Higher yields, lower production costs, and reduced erosion and land degradations are all benefits of zero- or no-tillage and soil conservation. Furthermore, they improve environmental quality by emitting fewer greenhouse gases (and thus reducing air pollution) by minimising the consumption of diesel fuel and not burning rice wastes. To maintain or improve natural soil fertility, there is minimal or no soil disturbance, which is sometimes supplemented with residue retention, crop rotation, and the use of cover crops. Direct seed dissemination is widely used in this method (Rosegrant *et al.*, 2014).

4. Polycultures with different crop types and patterns

Intercropping with a mix of short and long duration crops, shallow and deep-rooted crops, legume and nonlegume crops, and legume and nonlegume crops is a climate-resilient technique because the system can cope well with varying rainfall. Furthermore, when legume and nonlegume crops are cultivated together, synergy and complementarity are better utilised. Farmers should examine diversifying with crops that provide dependable revenue and strong returns. Ghosh et al. (2006) used the ability of innovative crops to withstand moisture stress or rainfall unpredictability superior to present crops as a factor in their selection.

5. Changes in agricultural management techniques

Farmers in many countries divided their agricultural plots into two half and employed various management approaches to deal with the uncertainty of rainfall. For example, Half of the rice plot is planted with traditional damp paddy-rice techniques (which can tolerate heavy rain), and the other half with a drought-resistant, less

water-intensive "system of rice intensification" farming technique (Resurreccion, Sajor & Fajber, 2008).

6. Irrigation timetables

Within each sector, the efficiency with which growers utilise their irrigation water will vary greatly, and one important element is the capacity to effectively schedule irrigation. When a sophisticated irrigation scheduling technique is utilised, significant water savings can be realised without affecting Class 1 yields. Benchmarking is a critical first step toward improving on-farm water use efficiency by identifying and promoting current industry "best practise" (Else and Atkinson, 2010).

CONCLUSIONS:

Climate change has a significant impact on smallholder and marginal farmers. These impacts vary depending on the stage of crop development. This group of marginalised farmers is particularly vulnerable to climate change because of their low socioeconomic level, lack of weather information, difficulty obtaining inputs, lack of understanding of climate change adaptations, and lack of technological competence. To boost these farmers' resilience, climate-smart agriculture strategies must be employed. Growing agriculture needs the use of modern equipment which will help farmers to grow their crops well.

From this study, it was evident that there are certain regional variances in extension problems and that certain differences in farmers' needs in Nagpur and Amravati do exist as well. Related difficulties in extension service exist and they are mainly related to the lack of trust in the government that reflects itself on the extension service and their work. However, the recommendations are broad, and there is a need to speed up the extension study to determine the depth of the impact of extension practises in terms of, say, doubling farmer income, advancing technological information, and raising awareness about sustainable agriculture to create a positive perception among farmers. Also, modern technologies at a very low price and easy availability can improve their financial as well as agricultural livelihood. So, if both the recommended sustainable farming technology as well as good agricultural practices are used together at ground level, then the smallholder as well as marginal farmers will surely get benefited and can fulfil the future food demand. Additional support mechanisms are required to make climate-smart agriculture operate. The numerous aspects of this issue would also be better appreciated with a pan-Indian study.

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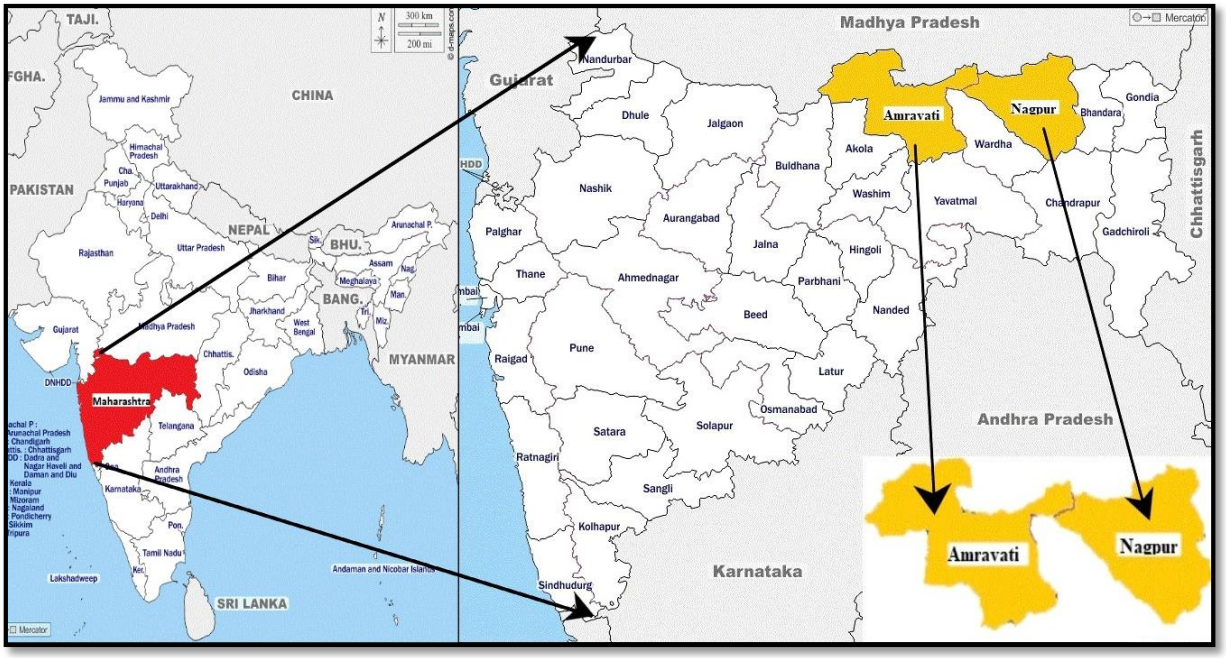

Fig 1: Study Area

Table 1: Major problems and thrust areas identified in selected district

Districts	Major Crops & Enterprises	Major Problems Identified
Nagpur	Orange, Cotton, sugarcane, wheat, Soya-bean, pulses, mung, gram, maize, linseed, paddy, tur, Papaya, tomato, Vegetables, Cattle, poultry, green chilly	• Plant diseases such as citrus canker have harmed citrus production and economics. • Late or No seed germination • Non-Availability of Orange saplings • Fluctuating market prices for cotton • Less productivity due to marginal land • Absence of modern technology in cultivation as well as ginning • Decreasing and stagnant yields with deteriorating quality and productivity of soil due to incessant use of pesticides and pests that are becoming increasingly resistant to chemical dosage. • Inadequate training to citrus growers • Unavailability of verities • The rising cost of production of seeds, fertilizers, and labour i.e. input costs is an issue. • Bollworm disease is uncontrollable decreases the quality of cotton. • Climate change shifts paddy farming to cotton farming. • Temperature change reduces the quality of orange. • powdery mildew disease affects chilli plant leaves, typically in the flowering and fruiting stage

Amravati	Groundnut, Orange banana, tur, cotton, Papaya, wheat, soya bean, cattle's, goats, pulses, mung, gram, maize, tomato, soybean, vegetables,	• Low-quality planting materials • Water scarcity makes slow growth of a plant. • Nutrient Deficiency in Groundnut. • Lack of interaction with the technology generators or researchers • Chilli plant leaf burn due to high temperature and water scarcity • Poor irrigation facilities, exposing production to monsoon fluctuations. • Weak extension support • Due to deterioration in genetic purity of cotton varieties and hybrid seeds, it becomes difficult to assess the quality of cotton • Water management • Delay in seed germination • Lack of soil nutrient management • Labour unavailability • Lack of awareness in modern farming technology. • Weed management and marketing of soybean

Table 2: Good agriculture extension practices found in Amravati and Nagpur districts

No.	Good Extension Practices	Descriptions
1	Farmers Group Discussion with Scientist	A farmer from nearby villages come together in a group for a long-duration discussion on how the scientist-farmer interface could be strengthened.
2	Voice mail	Short voice messages on different crops updated information given to farmers mobile.
3	News Paper (Agrowon, Krishak-Kosh)	Latest technology and all agricultural information countrywide as well as worldwide obtained by farmers in local language newspaper.
4	WhatsApp	Latest innovations & ideas in agriculture, as well as problems of farmers, solve by experts, scientists and progressive farmers instantly with the use of social media extension what's app
5	SMS	SMS advisory service is used by the different public, private as well as Public-private sectors to share the knowledge of agricultural farm practices.
6	Fortnight Scientific Diagnostic Surveys and Solutions	Fortnightly diagnostic surveys made by the Agri Scientist to different farmers' fields to find the problems and the solutions provided to them.
7	YouTube	It is the most valuable video-based social media platform used by farmers which improves farmers' knowledge of farming.
9	Monthly Question and Answer session	A group of farmers session arranged monthly where farmers from different villages solve each other's problems
10	Experts and Scientist Talks	Agriculture Scientists and experts from different sectors are invited to share knowledge with farmers and for their capacity development.
11	Television (aamchi maati- aamchi manse)	It is the visual mass advisory platform by which farmers come to know about different agricultural and farm-related information
12	Discussion with progressive farmers	Progressive farmers or successive farmers play an important role in rural development by sharing their personal farming experiences.
13	Weekly farmers meeting (Kisan Goshti)	Weekly farmer's meetings are undertaken by the extension personnel to give information on the latest technology, Schemes, good practices with the help of PowerPoint presentations and educational videos. Also, check the crop status of farmers.
14	Vehicle canvass awareness rally	Information, Scheme or new updated agricultural knowledge as well as farming advisory given to farmers with the help of advertisement hoardings and posters mounted in a vehicle and at the same time audio mic used for giving information by audio messages, Sometimes leaflets also distributed to farmers