International Journal of Ecology and Environmental Sciences 48: 547-569, 2022
ISSN: 2320-5199 (Online); https://doi.org/10.55863/ijees.2022.0547

Promoting Climate-Smart Agriculture through Policies and Schemes in India: Temporal and Strategic Overview

Y.D. IMRAN KHAN[1], MRINALINI GOSWAMI[1], ANIL K GUPTA[2], A. PREMKUMAR[1] SWETA BAIDYA[2], SATYA PRAKASH[1] AND SUNIL NAUTIYAL[1*]

[1]Centre for Ecological Economics and Natural Resources (CEENR), Institute for Social and Economic Change (ISEC), Nagarabhavi, Bengaluru - 560 072, India

[2]Environment Climate Disaster Risk Management Division, Ministry of Home Affairs, Government of India, Sector 29, Rohini, New Delhi – 110 042, India.

E-mail: ikeducationkhan08@gmail.com, goswamimrinalini@gmail.com, anilg.gov.in@gmail.com, premkumar1074@gmail.com, drswetabaidya@gmail.com, satyaprakash724.sp@gmail.com, nautiyal_sunil@rediffmail.com

***Corresponding author**

ABSTRACT

The challenges of climate change are now being experienced by all the countries in the world through higher average temperatures, variability in precipitation, rise in sea level and more frequent climatic extremes. Climate change is emerging as a major threat to the livelihood and food security of millions of people around the world. It directly affects the natural resources sectors, especially in developing countries, and the economies of the people depend on them. Thus it indirectly affects economic growth, income distribution, household welfare, food and nutritional security. In this dilemma, the concept of climate-smart livelihoods or climate-smart agriculture emerged as one of the doable solutions which seem to have the potential to handle climate change impacts. Throughout the world and more particularly in countries most dependent on agriculture, the policies are framed and implemented to support a large population on one hand and sustaining the economy and food security on the other. India is one of countries where agriculture and allied sectors are the primary sources of livelihood for more than 60% of the country's population. Therefore, the Government of India (GoI) has introduced several policies, programmes and schemes to improve and strengthen Indian agriculture. Policies introduced in recent years focus on climate-smart agriculture (CSA) practices. This article attempts to look into existing policies and programmes in agriculture and allied sectors to understand the perspectives in detail and analyse the outcomes aligning with the production, resilience and mitigation under the broad framework of CSA.

Key words: Climate Change, Climate-Smart Agriculture, Extreme Events.

INTRODUCTION

In 21st century, the challenges of climate change are now being experienced on a human scale across all the countries in the globe through higher average temperatures, variability in precipitation, rise in sea level and more frequent climatic extremes (Sam et al. 2017, Arnell et al. 2019, Makate 2019, Cradock-Henry 2020). According to the fifth assessment report of the IPCC, climate change is emerging as a major threat to the livelihood and food security of millions of people in many places of the world (IPCC 2014). The list of effects of climate change is very long starting from glacier melting, sea level rise, floods/ drought to water availability and biodiversity loss. Eventually, it is causing an impact on agriculture and allied sectors, particularly affecting the livelihoods of poor and marginalized society (Rao et al. 2019).

The agriculture sector is the backbone of Indian economy which contributes 20% to the Gross Domestic Product (GDP) of the nation (NAFP 2014). Agriculture and its allied sectors (livestock production, forestry, fishing, and cultivation of crops) are conclusively the largest livelihood provider in India, particularly in rural areas. The post-independence agriculture sector in India has gone through many positive changes due to various initiatives where significant importance is given in formulating and implementing policies for agricultural development by the Government of India. Moreover, the agriculture sector has also been affected and faced several challenges due to various calamities such as floods, drought, hailstorms, uneven rainfall etc. These calamities impacted the production and productivity of crops which have collectively shown the effects on the food security

of the nation. In India, marginal (< 1 ha or < 2.5 acres) and small farmers (1-2 ha or 2.5-5 acres) share the largest area of agriculture land and they are worse affected by climate related stresses. Trend pattern (1970 to 2016) of number of operational holding and area of agriculture land operated by different operational holdings are depicted in Figures 1 and 2 (Agriculture Census, 1970-71 to 2015-16). Small and marginal farmers are more vulnerable to the impacts of climate change because of their low levels of income, limited resources, lack of alternative livelihoods, low crisis management capabilities and income safety net (Kumar et al. 2016, Panda and Singh 2016, Panda 2017).

Agriculture is understood as the most climate sensitive activity in India (Mahdi 2019). Changes in climatic parameters such as uneven rainfall, rise in temperature and extreme weather events are showing negative effects on agriculture growth and food security (Mall et al. 2006). In India, it is assessed that the contribution of the agriculture sector to the GDP is shrinking (Fig. 3); however, this sector provides more employment and livelihoods for more than 58 per cent of the country's population (IBEF 2020; IPCC 2014). The agriculture sector is also a significant contributor to Green House Gas (GHG)

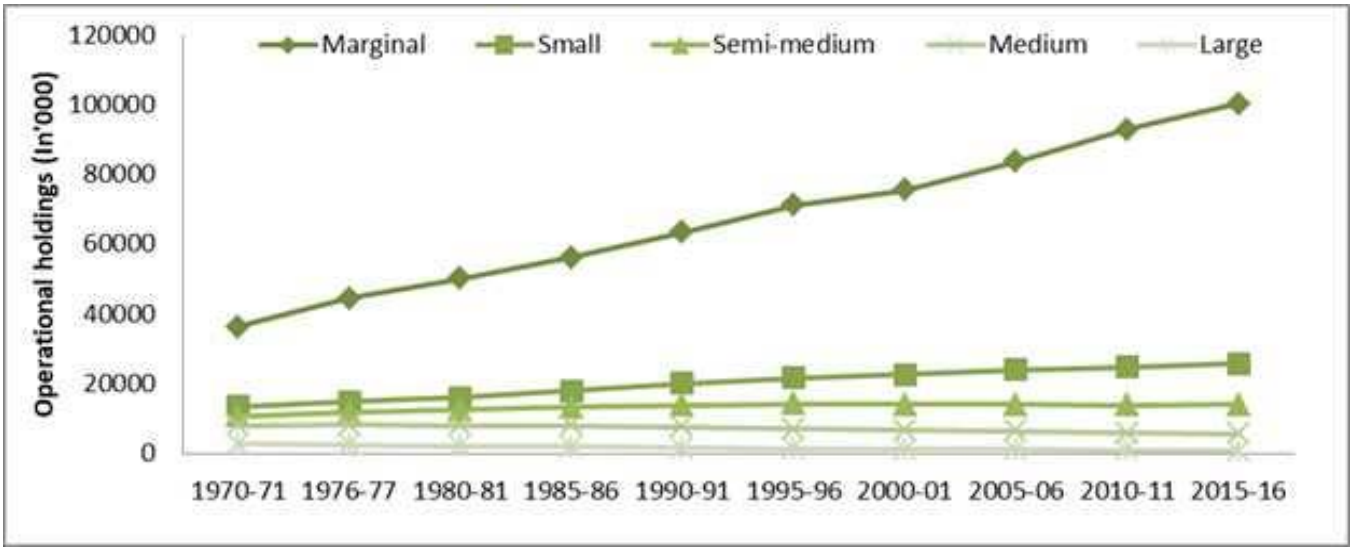

Figure 1. Number of operational holdings in India during 1970 to 2016 (Source: Agriculture Census, GoI)

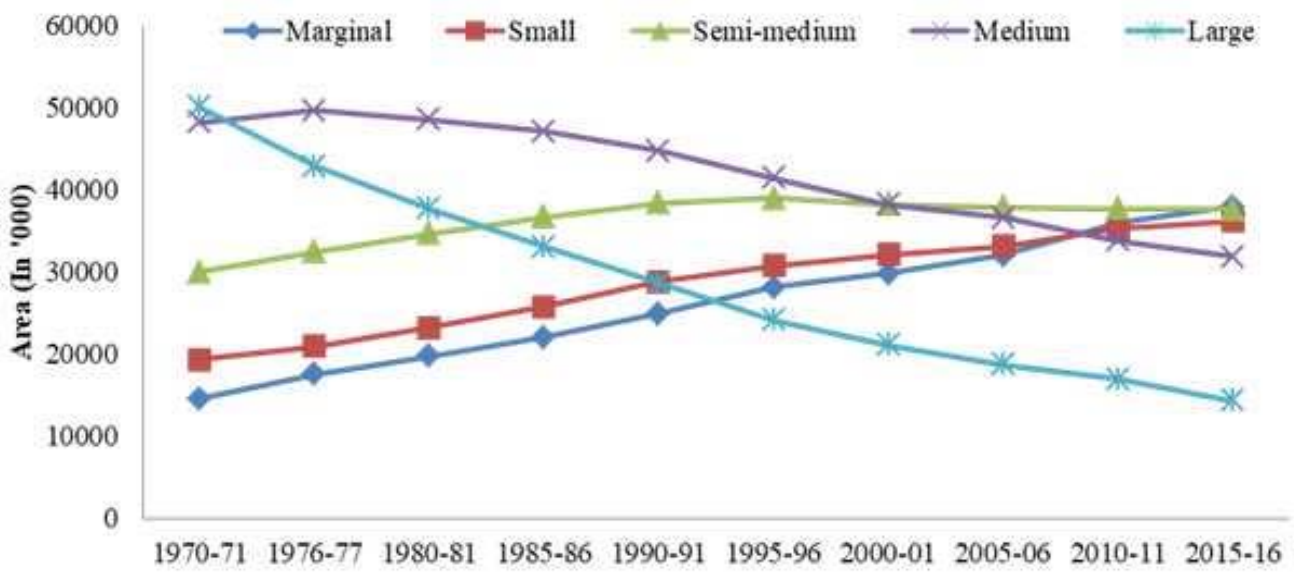

Figure 2. Area (ha) operated by operational holdings during 1970-2016 (Source: Agriculture Census, GoI)

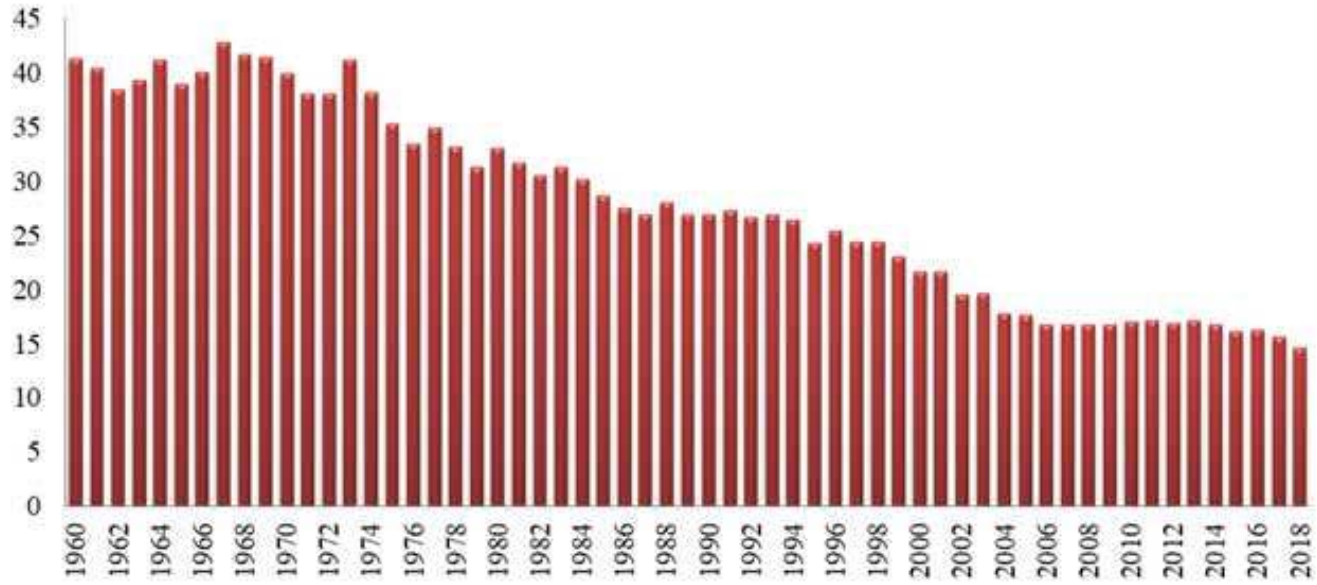

Figure 3. GDP share (%) of agriculture in India during 1960 to 2018 (Source: www.theglobaleconomy.com, The World Bank)

emissions. Worldwide, 11.3% (5677 MT CO_2 equivalent) share of GHG emissions comes from the agriculture sector where as in India the total share of GHG emissions from the sector was 7.1% (406 Mt CO_2 equivalent) of the total GHG emissions in the year 2010. In India, the GHG Emissions from the agriculture sector was increasing (from 1970 to present, the GHGs emissions from Indian agriculture have increased by about 75%) due to excessive usage of fertilizers and other agricultural inputs besides the rising numbers of livestock, crop residue burning and other practices in agriculture (Jain et al. 2014, Pathak et al. 2014). Against this background of food insecurity and increasing GHG emissions, the need is evident to review and restructure agricultural policies and initiatives to facilitate a paradigm shift in agricultural development approaches to adapt and build climate resilience. There are several potential options to reduce climatic risks in agriculture and one such option is Climate-Smart Agriculture (CSA) (Khatri-Chhetri et al. 2017).

CSA is an integrated approach for managing landscapes, cropland, livestock, forests and fisheries, that address the interlinked challenges of food security and climate change. Food and Agricultural Organization (FAO) defines CSA as 'agriculture that sustainably increases productivity and incomes, enhances resilience (adaptation), reduces greenhouse gas (mitigation) where possible, and enhances achievement of national food security and development goals' (FAO 2018). In the changing climatic situation, the CSA approach helps agricultural systems to support rural development and ensure food security (Amadu et al. 2020). CSA initiatives may include technological, institutional or knowledge support for crop/ production improvement and resource (soil and water) management. Increased productivity aims to produce more food to improve food and nutritional security and boost the incomes of rural poor who depends on agriculture for their livelihoods. Enhanced resilience is to reduce vulnerability to climate change, climatic extremes and other shocks; and also tries to improve capacity to adapt. CSA has been practiced and evolving in almost all the states in India. Khowai of Tripura state has one of the best examples for adoption of CSA practice. In Khowai, as a part of natural resource management, water harvesting structures and recycling of organic wastes; as a part of production management, the System of Rice Intensification (SRI) method, in-situ moisture conservation, integrated pest management; integrated farming system; institutional intervention such as Custom Hiring Centre (CHC) was successfully introduced with visible outcomes (Nath 2017-18). After the intervention, during 2016-17 approximately

26187 ft^3 rainwater was harvested covering an area of 35 ha for rabi maize cultivation and winter vegetable crops. The adoption of organic waste recycling technology, on an average of 5 qt of vermicompost along with 15 litres of vermiwash were produced by each beneficiary. SRI intervention has shown an increase of income from Rs 0.1 lakh per hectare to Rs 0.9 lakh per hectare. Pheromone traps were introduced as a pest management practice which was proven to be effective.

Actions initiated are to attain lower GHG emissions for each kilo calorie of food produced, avoid deforestation for agriculture and identify ways to draw carbon out of the atmosphere (World Bank 2019). CSA needs to be integrated in to agriculture and other development policies and while mainstreaming for wider adoption at scale. Since post-Independence India's focus has been food self-sufficiency in terms of cereals- rice and wheat through intensification of agriculture (OECD/ ICRIER 2018). Initially, these policies emphasized land reforms, expansion of agricultural land and restructuring of rural institutions. Prior to the 1990s, the policies were formulated without linking them to environmental issues. However, in recent years, the Government of India has launched various flagship programmes which are addressing climate change and related concerns. Among them, National Innovations on Climate Resilient Agriculture (NICRA) is one of the flagship network projects of the ICAR launched in the year 2011. NICRA supports nationwide effort through research and is piloting established Climate Resilient Villages across the country; so far 446 villages have been established (Gupta et al. 2019). Collaborative promotion and implementation of CSA technologies, practices and services with communities as Climate-Smart Villages are also paving its way from Maharashtra, Madhya Pradesh and Haryana.

Creating an enabling environment for policy and regulations, investments, access to knowledge and technology is essential for the effective adoption of CSA technology and practice. These policies and programmes provide guidelines with appropriate objectives, consistency in planning, accountability, efficiency, and clarity in a system for proper implementation and proliferation of climate-smart practices. There is no documentation or identification of the space provided for climate-smart initiatives in agriculture and related policies in India. This article attempts to look into the existing policies and programmes in agriculture and allied fields to understand various government programmes with relation to agriculture and analyse their alignment with the three pillars of CSA (production, resilience and mitigation).

METHODOLOGY

The review of policies/ schemes procedure involves four-phases (Fig. 4). The first phase includes listing out all the agriculture policies and schemes which were introduced during the post-Independence period (1947 to present). The second phase includes screening the policies based on various management practices (crop management, water management, soil management, nutrient management, risk reduction, technology and capacity building) of CSA. In the third phase, policies / schemes were segregated which supports CSA practices and in the last phase, a systematic review was done based on the execution of the policies and schemes.

A systematic review on policies / schemes related to CSA was carried out on the initiatives taken by the Government of India (GoI) for the development of agriculture during post-Independence. Also, several recent policies were reviewed and documented, which were framed and implemented by the government of India effectively in recent years. In that, different policies/schemes which are emphasizing climate change and agriculture were segregated under various heads of CSA. Further, a detailed policy analysis was done based on previous studies.

RESULTS AND DISCUSSION

Evolution of environmental concern in agriculture during post-independence period / Five Year Plans

Since Independence, India has made advancements in agriculture. The agriculture growth rate was 1% per annum during 50 years of pre-Independence, it has grown at 2.6% per annum during the post-Independence era. During the late fifties and sixties, expansion of the land area under agriculture production was the main concern and the rate of expansion has gradually decreased over time. In recent decades, an increase in productivity became

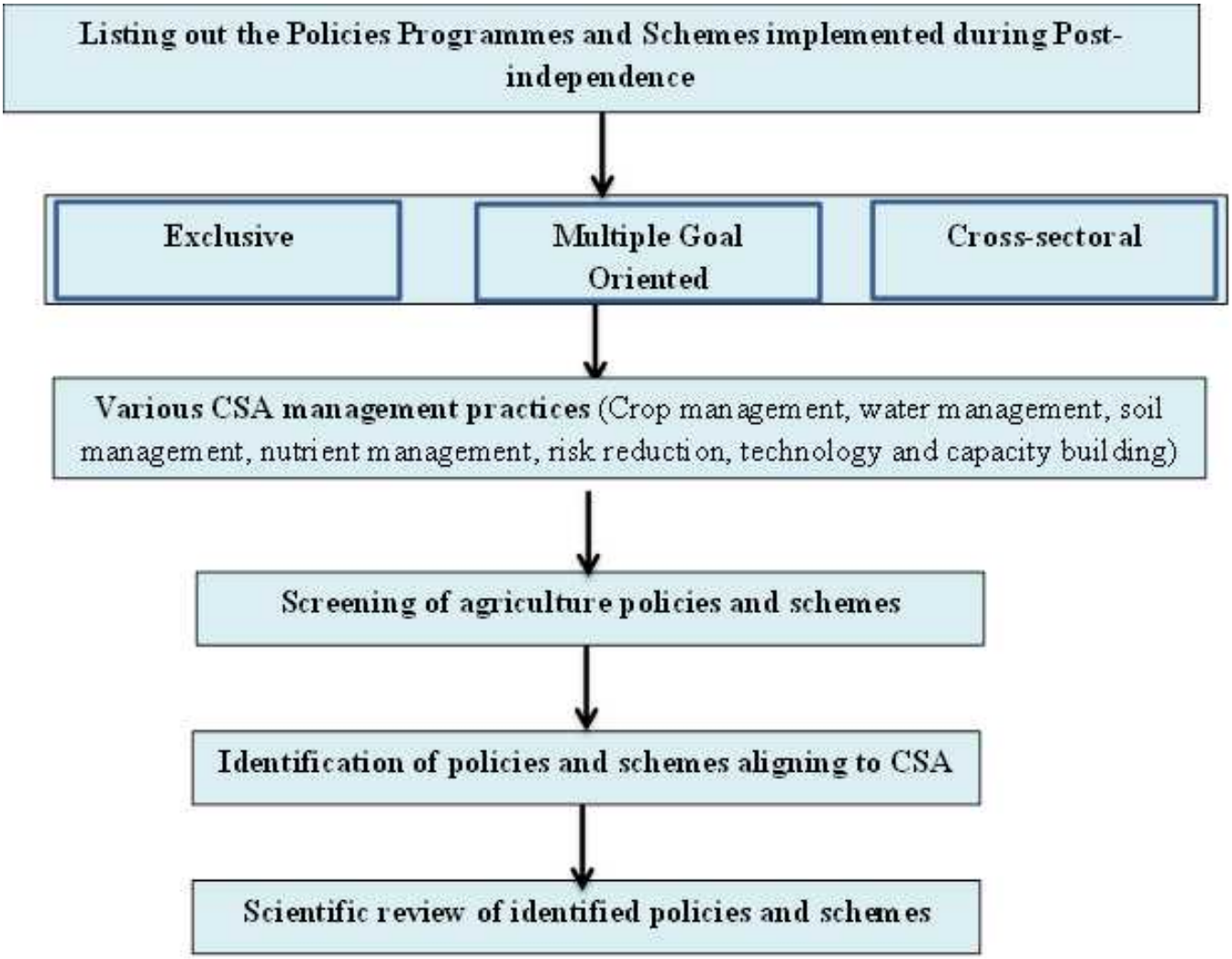

Figure 4. Methodological approach

the main driver of growth in the production of agriculture (Tripati and Prasad 2009). During the post-Independence period, Indian agriculture has undergone several changes and progressed with accelerating speed not only in terms of yield and output, but also structural changes. Until the initiation of economic reforms in 1991, India's agricultural policy largely constituted the planning of the economy (Bhalla 2007). The structural developments in Indian agriculture have taken place in phase wise manner during Five Year Plans (FYPs). Not much importance was given to the environment in agriculture in the early stages of FYPs. Gradually the concern on environment and sustainability concepts were evolved over a period of time. A series of steps such as land reforms, industrialization, increasing crop production, irrigation development (micro and macro irrigation), adoption of high yielding varieties, increasing production of food grains, oil seed development, insurance, agriculture diversification, strengthening technology and water conservation strategies were involved in agriculture development during post-Independence in all the 12th FYP (Table 1). The structural changes in agriculture led to environmental degradation at various levels including loss of top-soil, pollution by agro-chemicals, mis-managed water resources and energy use. However, much concern towards the environment and sustainability was given in the 11th and 12th FYPs. In recent years (2007 onwards), various flagship programmes, schemes and policies were implemented by GoI (Fig. 5). These programmes and schemes not only support to increase the agriculture productivity and yields also help the farmers to fight climate change extreme events.

Table 1. Features of agriculture sector during Five Year Plans (FYP)

1st FYP (1951-56)
- Approximately 31% allocations for agriculture.
- Abolition of Zamindari system
- Target areas: Agriculture and allied sectors animal husbandry, fisheries and soil conservation.
- Food grains increased from 54 million tonnes to 65.8 million tonnes

2nd FYP (1956-61)
- Approx 20% allocations were given to agriculture sector as priority was given to industrial sector.
- 80.5 million tons of food production was the target, however 79.7 million tons was the actual production.
- Faced shortage in agricultural production. Imported food grains to meet the food shortage.

3rd FYP (1961-66)
- The main objective of the plan was to increase the agriculture production to meet the needs of industry and export both.
- Primary priority was given to agriculture sector, beside to this priority was given to irrigation and industry as well.
- Programmes such as High Yielding Variety (HYV) programmes and Intensive Agriculture District Programme (IADP) were introduced.
- Green revolution
- Embattled to upsurge overall agriculture by 30%, however the production increased by only 10% due to drought conditions during 1965-66.

Three annual plans (1966-69)
- Top most priority was given to minor irrigation followed by adaptation of HYV programme.
- During this plan govt set up Food Corporation of India (FCI) for maintaining buffer stock and Agriculture Price Commission to assure MSP to farmers.

4th FYP (1969-74)
- 23% allocation for agriculture.
- Increasing food production by providing favorable economic conditions to inject advance technologies and enabling rural population to participate in the development of agriculture and share its benefits are the major agriculture related objectives.
- Food grain production was increased during this period.
- First two years of this plan showed good production. The last three years did not show expected production due to monsoon failure.
- For the year 1973-74, target for food grain production was 129 million tones, however the actual production was 104.7 million tones

5th FYP (1974-79)
- Top priority was given to agriculture.
- 21% of allocation for agriculture production
- Promotion of greater use of fertilizer, pesticides, insecticides and cultivation of HYV seeds.

6th FYP (1979- 83)
- 24% allocation for agriculture
- During this period food grain production was increased to 152 metric tons.
- Annual agriculture growth rate was 4.3%

7th FYP (1985-1990)
- During this plan period additional importance was given to projects like National Oilseeds Development Project (NODP), special rice production programme particularly in the eastern Region, National Watershed Programme (NWP) for development of rain fed agriculture and social forestry etc.
- Much focus was given to policies and programmes for growth in food grain production.

8th FYP (1992-97)
- New Economic Policy (NEP) was introduced in 1991.
- The main features of the new economic policy are privatisation, globalization, liberalisation, modernisation, new public sector policy, financial and fiscal reforms. Agro processing industries were boomed besides to this exports of agriculture were increased.

9th FYP (1997-02)
- Agriculture development strategies were prepared based on the agro-economic situations of regions.
- National Agriculture Policy 2000 was introduced.
- Various initiatives and policy measures such as implementation of National Agriculture Insurance Scheme (NAIS), National Seed Policy (NSP), prepared legislation for farmer rights and plant variety protection, development of horticulture in NE region and watershed development fund with NABARD were taken during this policy period.
- Targeted growth rate was 3.9% but achieved only 2.06%.
- Food grain production was increased however; production of pulses was marginally decreased.

10th FYP (2002-07)
- Agriculture diversification, water conservation, strengthening technology in agriculture, dissemination and demonstration of technology and development of infrastructure related to agriculture are the major features during this plan period.
- Various programmes such as, Micro Irrigation (MI), Jute Technology Mission (JTM), National Horticulture Mission (NHM), National Agriculture Innovation Project (NAIP), National Fisheries Development Board (NFDB), National Gender Resource Centre in Agriculture (NGRCA) and National Mission on Bamboo Technology and Trade Development (NMBTTD) were introduced by Ministry of Agriculture.
- Beside to these programmes, government taken initiatives to setup and introduced Krishi Vigyan Kendras (KVKs), The National Rainfed Area Authority (NRAA) and Agriculture Technology Management Agencies (ATMAs).

11th FYP (2007-12)
- Various flagship programmes such as Rashtriya Krishi Vikasa Yojana (RKVY), National Food Security Mission (NFSM), National Mission for Sustainable Agriculture (NMSA), National Project on Management of Soil Health and Fertility (NPMSHF), Integrated Scheme of Oil Seeds, Pulses, Oil Palm, and Maize (ISOPOM) and Macro Management of Agriculture (MMA).
- Increasing agriculture production, limited usage of natural resources in agriculture and improving the access to technology are the main features related to agriculture.

12th FYP (2012-2017)
- More attention was given to RKVY Programme.

  Five Missions:

  National Food Security Mission; National Horticulture Mission; National Mission on Oil seeds and Oil palm; National mission on Agriculture Extention and Technology; National Mission on Sustainable Agriculture

  Four central sector schemes:

  Integrated scheme on agricultural marketing; Integrating scheme on agriculture cooperation; Integrated scheme for farmenrs income security; Integrated scheme on Agri. Census and Statistics

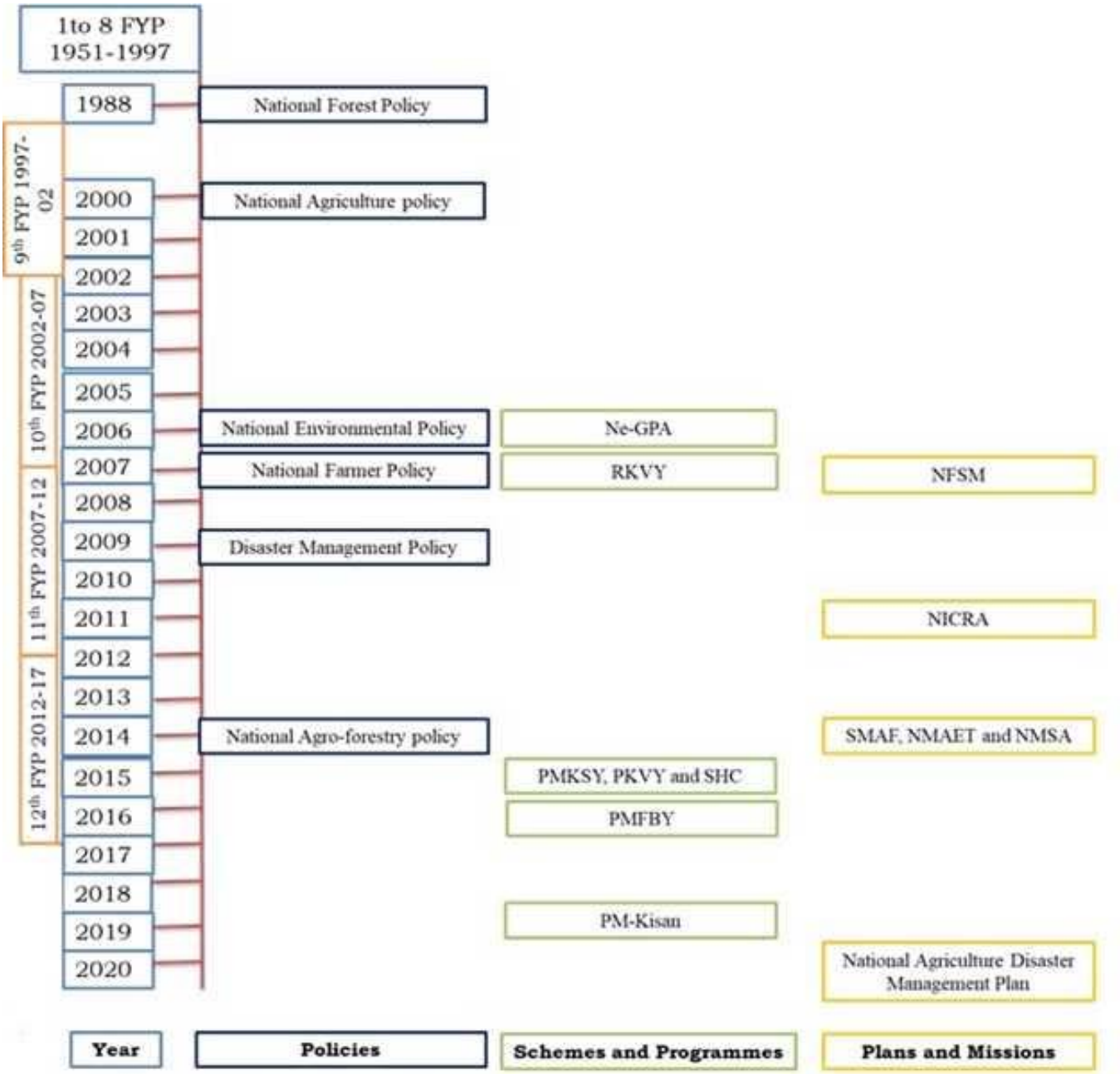

Figure 5. Schematic figure of policies, schemes and programmes of agriculture in chronological order

AGRICULTURE POLICIES AND SCHEMES IN INDIA

National Agriculture Policy (NAP) (2000)

The decline in the contribution of the agriculture sector to the GDP has affected most of the farmers especially those in the marginal and small farmers group. To resolve these problems of livelihood and to improve the agricultural sector of the country, the first National Agricultural Policy (NAP) was formulated on 28th July 2000 with the objective of technologically, environmentally and economically sustainable agricultural growth. The annual growth rate for the sector was fixed at 4 percent with efficient

use of resources. The major focus of NAP 2000 was to strengthen rural infrastructure to boost agricultural development, generate employment in rural areas, and improve the standard of living of farmers and workers engaged in agriculture. The objectives of this policy are to increase the growth rate over 4% per annum in the agriculture sector by efficient usage of resources. The main features and focus area of this policy is macro management approach; promotion of sustainable agriculture by efficient usage of natural resources such as soil, water, environment and biodiversity etc.; providing sufficient and timely inputs to farmers; women empowerment; promoting private sector participation in agriculture and tenancy reforms.

National Policy for Farmers (2007)

In 2006, National Commission on Farmers (NCF) submitted the final report on National Policy for Farmers (NPF) to the Government of India (GOI) based on a draft report compiled by NCF in conslutation with state governments. Based on Prof. M. S. Swaminathan's, chairman of NCFs report, the government approved the National Policy of Farmers in 2007. NPF-2007 aimed to enhance the economic sustainability of farming and increase the net income of farmers. The policy objectives include asset reforms concerning water, land, livestock, fisheries and biodiversity; providing appropriate price and trade policy mechanisms; health and trade security of farmer families; social security system for farmers; supply of disease-free planting material and quality seeds; mainstreaming the human and gender dimension; support services for women; proper use of information and communication technology; restructuring the agricultural curriculum and pedagogic methodologies for enabling every farm and home science graduate to become an entrepreneur and to make agricultural education gender-sensitive; social security systems of the farmers; development of agriculture market infrastructure; effective execution of Minimum Support Price (MSP); establishing community foodgrain banks; implementation of timely and easily reachable institutional credit and providing appropriate opportunities inadequate measure for non-farm employment for the farm households. Other focus areas of the policy include initiation of rural non-farm employment, promotion of organic farming, application of frontier technology in agriculture and coverage of farmers under a comprehensive national social security scheme etc.

Remunerative Approach for Agriculture and Allied sector Rejuvenation (RKVY-RAFTAAR)

In 2007, the Government of India launched this Programme. Previously it was known as Rashtriya Krishi Vikas Yojana (RKVY). Till 2013-14, the scheme was implemented as additional central support to state plan scheme with 100% central government grant. Later in 2014-15, this scheme was converted into a Centrally Sponsored Scheme with 100% central assistance. But since 2015-16, the funding pattern has been altered between central and states in the ratio of 60:40. However, the ratio patterns in NE states and Himalayan states are 90:10, for UTs' the funding pattern is 100% central grant. This scheme will integrate agriculture and allied sectors such as crop husbandry (including horticulture), animal husbandry, dairy development and fisheries, agricultural research and education, agricultural marketing, Food storage and warehousing, soil and water conservation, agricultural financial institutions, other agriculture programmes and cooperation. This scheme also encourages convergence with other programmes. Preparation of the district and state agriculture plans is mandatory in this yojana. Based on feedback during the implementation of RKVY in the 12th FYP, RKVY guidelines have been refurbished as RKVY-RAFTAAR to enhance the effectiveness, efficiency and inclusiveness of the programme for the outstanding period of the 14th finance commission. RKVY-RAFTAAR aims at making farming a remunerative economic activity through strengthening the farmer's effort, risk mitigation and promoting agri-business entrepreneurship. The main aim of this scheme is to strengthen the farmer's efforts by creating required pre and post-harvest agri-infrastructure that increases access to quality inputs, storage, market facilities etc. and enables farmers to make informed choices. This programme is also expected to support farmers to mitigate risk and empower the youth through skill development, innovation and agri-entrepreneurship based agri-business models to attract them to agriculture. Integrated development of food crops, which includes cereals, minor millets and pulses, farm mechanisation, soil health, rain-fed farming

systems, integrated pest management, promoting extension services, horticulture, animal husbandry, dairying & fisheries, sericulture, study tours of farmers, organic and bio-fertilizers and formulating innovative schemes are the major focus areas of this scheme (RKVY-RAFTAAR 2017-18 to 2019-20).

Promotion of on-farm water management through watersheds, promotion of micro-irrigation nutrient management are the significant climate-smart interventions under this programme. It reported a 10-20% increase in farmer's income, 36% savings in fertilizer usage and 44% water saving due to the implementation of different water management practices under this programme (Kumar et al. 2013). Similarly, due to nutrient management farmers obtained a 10% increase in productivity. It has also been observed that 11% increase in income of the farmers, 17% saving in fertilizer usage and 12% saving in water due to the promotion of climate-smart interventions under RKVY (Kishore et al 2018). It is evident that due to the interventions of this programme farmer income has been increasing significantly and also contributing to energy and resource saving which are key components of CSA (Kumar et al. 2013).

National Food Security Mission (NFSM)

In 2007, the National Development Council (NDC) launched the National Food Security Mission (NFSM) to increase the production of rice by 10 million tons, 8 million tonnes for wheat and 2 million tons of pulses by the end of the eleventh plan. The main aim of this mission is to increase the production of cereals crops, restore soil fertility and productivity at the individual farm level and enhance the farm level economy.

By the end of the 11th FYP, NFSM achieved all goals and the production of rice, wheat and pulses increased during the programme (NFSM Online). Seeing the success of NFSM, it was continued further to the 12th FYP with new targets and goals. NFSM was divided broadly in to five categories (1) NFSM-Rice, (2) NFSM-Wheat, (3) NFSM-Pulses, (4) NFSM-Coarse cereals and (5) NFSM-Commercial crops targeting 25 million tonness of additional food grain production by the end of the 12th FYP. To achieve this goal and ensure another successful implementation of NFSM, the government formed committees at the national level referred to as General Council (GC), at the state level called the State Food Security Mission Executive Committee (SFSMEC) and at the district level the scheme was governed by Agricultural Technology Management Agency (ATMA).

Keeping food security as a focus, to address the challenges of food unavailability, the Government of India launched National Food Security Mission (NFSM) in 2007. The mission aimed to increase the production of rice, wheat and pulses. Later, this programme has been expanded to include commercial crops and coarse cereals. The key measures adopted to increase the productivity are acceleration of quality seed (HYV) production, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Promotion of technologies, restoring soil fertility, supply of adequate and timely inputs and introduction of pilot projects (Manjunatha and Kumar 2015). These interventions which are adopted in this programme are mostly climate-smart interventions (Kumar and Ladha 2011).

A study conducted by Joshi (2011) summarized that by adopting the CSA interventions, 20-35% saving in water thus 60-90% saving in energy and 5-10% decrease in cost, with this farmer income may increase to 15-27%. Other researches also show similar findings (Kishore et al 2018). This Programme is contributing to different climate-smart management practices such as crop management, water management, soil, nutrient management, technological management and capacity building by aligning the three pillars of CSA.

National Mission for Sustainable Agriculture (NMSA)

NMSA is one of the eight missions under the National Action Plan on Climate Change (NAPCC) which was formulated in the year 2014-15. NMSA was introduced with the mandate to increase agriculture productivity, particularly in rain-fed areas. Enhancing livelihood opportunities, food security and minimizing crop failures are the major salient features of this programme. This scheme promotes and encourages on-farm and off-farm resource conservation technologies, effective management of available water resources, promoting Integrated Farming System (IFS), improved agronomic practices such as increased water holding capacity, improved soil treatment, sensible use of chemicals/

energy and enhanced soil carbon storage, generating database on soil resources (land use survey, soil profile study and soil analysis on GIS platform, specific crop management practices & optimize fertilizer use), crop specific Integrated Nutrient Management (INM) practices, developing climate change adaptation and mitigation strategies by involving knowledge institutions and professionals, dissemination and adoption of rain-fed technologies in disadvantaged areas and preparing location specific planning is the salient feature of this programme. This scheme also encourages convergence from other schemes/missions such as MGNREGS, IWMP, RKVY, NFSM, MIDH, NMAE&T etc. National Mission for Sustainable Agriculture (NMSA) has a focus on rain-fed areas to improve water use efficiency, integrated farming, soil health management and synergizing resource conservation. NMSA has four major components i.e., Rain-fed Area Development (RAD), On Farm Water Management (OFWM), Soil Health Management (SHM) and Climate Change and Sustainable Agriculture: Monitoring, Modelling and Networking (CCSAMMN) (NMSA Online).

Sustainable agriculture assimilates three main goals – economic profitability, environmental health, and social equity. Though implementation of the mission was delayed till 2014, through the process of restructuring and convergence strategies by the Department of Agriculture and Cooperation (DAC), the NMSA has undergone significant refurbishment by mainstreaming the on-going agriculture development programmes. The latest impact evaluation reports stated that the INM practice promoted in this scheme is an operative intervention to save fertilizers (Ramappa and Manjunatha 2017). Another study has also shown that 20% yield was increased in cereals, 40% yield in legumes, 35% yield was increased in oil seeds due to the adoption of integrated management practices (Kishore et al. 2018, Wani et al. 2017). These studies highlighted that 7% of chemical fertilizers can be saved thus 5% income of the farmers can be increased by increasing the soil testing based on INM in India. However, a few available studies did not find any substantial impacts of Soil Health Cards on fertilizer use at the field level (Makadia 2015, Fishman 2016).

Pradhan Mantri Krishi Sinchai Yojana (Prime Minister Agricultural Irrigation Scheme)

The vision of Pradhan Mantri Krishi Sinchai Yojana (Scheme) **(**PMKSY) is to ensure access to protective irrigation for all agricultural farms. PMKSY was prepared by merging different ongoing schemes such as Accelerated Irrigation Benefit Programme (AIBP), Integrated Watershed Management Programme (IWMP), On-Farm Water Management (OFWM) and River Development and Ganga Rejuvenation. PMKSY is to be implemented in an area development approach adopting decentralized state-level planning and execution. States have to draw their irrigation development plans based on district/blocks plans with a horizon of 5 to 7 years. States can take up projects based on the District/State Irrigation Plan. All the States and Union Territories are covered under this programme. Carrying out extension activities in the field with a special focus on water harvesting, water management and crop alignment for farmers and grass-roots level field functionaries. This scheme also encourages convergence with other programmes such as MNREGS. The main aim of PMKSY is to extend the coverage of irrigation to every field and improve water use efficiency. Accelerated Irrigation Benefit Programme (AIBP), *Har Khet Ko Pani*, *Per Drop More Crop* and Watershed Development are the major components of this scheme (PMKSY online A).

Water management is one of the key management components in CSA particularly against droughts (Fishman 2011). Climate projections and observed data show that changes in water quality and quantity due to climate change negatively affect crop production; thus, it pushes small and marginal farmers to the verge of vulnerability (FAO 2016). Post-Independence, excessive investments have been made towards several irrigation projects in the country. Despite all these efforts and investments, more than 40% of land remained rain-fed. While a larger portion of the country is facing water scarcity, another section of the farmers is unsustainably using water in agriculture (Kishore et al. 2018). This situation can particularly be observed in drylands, arid and semi-arid landscapes (Nautiyal et al. 2015). To overcome this issue, farmers need to adopt sustainable water management practices such as drip irrigation, sprinkler irrigation, construction of farm

ponds and rain water harvesting (Khan et al. 2019; Reddy and Mukate 2019). In this regard, GoI launched the PMKSY by giving high priority to water conservation and its management practices with the vision of sustainable water management in agriculture.

Micro-irrigation under PMKSY's physical achievement during 2013-14 was 4.32 lakh ha and it reached 11.73 lakh ha in 2019-20 (Fig. 6). Similarly expenditure achievement was 1,181.25 crores during 2013-14 which was increased to 1,917.62 crores for the year 2019-20. Kishore et al. (2018) estimated that savings in water usage were reduced to 20%, where farmer's income increased to 5.0% in India, besides this, GHG emissions declined 3.2%. Therefore, the PMKSY scheme is contributing efficiently to water management which is a key component of CSA.

Sub-Mission on Agroforestry (SMAF)

This is a sub-mission operational under the umbrella of NMSA. The salient features of this Programme are an expansion of the coverage under tree plantation in arable land (trees suitable to local agro-climatic and land use conditions); promotion of setting up of new small nurseries and hi-tech big nurseries; promotion of agroforestry practices/models (promotion of sustainable agri-silvicultural systems, silvi-pastoral systems, agri-silvopastoral system, other systems of agroforestry such as Apiculture with Trees, Aqua forestry etc.); promotion of peripheral and boundary plantation; creation of a database on the area under agroforestry status; cultivation of the endemic and medicinal plant. The benefits of this scheme can be availed by farmers groups/ cooperatives/Farmer Producers Organization (FPO). However, the support can be given as per norms and provisions applicable to the individual farmers. As much as 50% of the allocated budget will be utilized for small, marginal farmers in which at least 30% are women beneficiaries/ farmers. The total budget, 16% and 8% will be allocated to SC/ST population in the district for Special Component Plan (SCP) and Tribal Sub-Plan (TSP) respectively. Agroforestry has the potential to mitigate the climate change effects through balance in microclimatic conditions, providing an additional source of livelihood, conservation of natural resources and income opportunities. Agro forestry development, climate change mitigation, providing livelihoods to the rural population, increasing income levels, biodiversity conservation are the major salient features of this programme (SMAF 2016).

Paramparagat Krishi Vikas Yojana (PKVY)

PKVY is an elaborated component of Soil Health Management (SHM) of the major project National Mission of Sustainable Agriculture (NMSA). A major objective of this programme is: **To promote organic farming by cluster approach and Participatory Guarantee System (PGS) certification**. Groups of farmers (fifty or more farmers will form a cluster having 50 acre land) can be motivated to take up organic farming under this scheme. Every farmer may be provided Rs. 20,000 per acre in three years for the seed to harvesting crops and to transport produce to the market. Organic farming is to be promoted by using locally available traditional

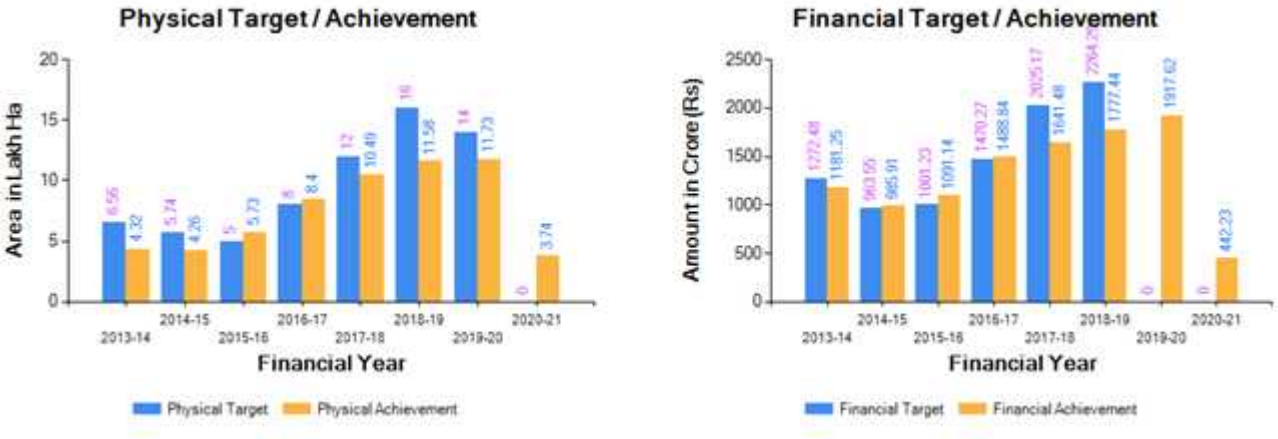

Figure 6. Per Drop More Crop - Micro Irrigation physical and financial targets and achievements 2013-14 to 2020-21 (Source: https://pmksy.gov.in/mis/frmDashboard.aspx)

resources and the organic products will be linked with the appropriate market. It is expected to increase domestic production and certification of organic produce by involving farmers. Soil health management is another important concern and focus of this programme.

Adoption of Participatory Guarantee System (PGS) certification through cluster approach (Mobilization of farmers / local people to form a cluster in 50 acres for PGS certification, PGS Certification and Quality control); **Adoption of organic village for manure management and biological nitrogen harvesting through cluster approach** (Action plan for Organic Farming for one cluster, Integrated Manure Management, Custom Hiring Centre (CHC) charges, Packing, Labelling and Branding of organic products of a cluster) are the major components and patterns of assistance in this programme.

National Mission on Agricultural Extension & Technology (NMAET)

The NMAET has been envisaged as the next step towards this objective through the amalgamation of 17 different schemes of the Department of Agriculture & Cooperation, Ministry of Agriculture and the Agriculture Technology Management Agency (ATMA). NMAET consists of four Sub-Missions i.e., Sub-Mission on Agricultural Extension (SMAE), Sub-Mission on Seed and Planting Material (SMSP), Sub-Mission on Agricultural Mechanization (SMAM), Sub-Mission on Plant Protection and Plant Quarantine (SMPP). Extension and technology are the major salient features of this programme. The objective of the scheme is to make the farmer-driven and farmer-accountable extension system by way of new institutional arrangements for technology dissemination. It aims to restructure and strengthen agricultural extension to enable the delivery of appropriate technology and improved agronomic practices to farmers.

Farm mechanization plays a prominent role in CSA. To achieve this National Mission on Agriculture Extension and Technology (NMAET) programme was launched in 2014. This mission consists of four Sub Missions of SMSP, SMAE, SMAM and SMPP NMAET will be converged with similar farmer-related activities going on through ATMA (NMAET online). Mechanization at the farm level will increase not only crop productivity, but also increase the cropping intensity and profitability (Kishore et al. 2018). The proper adoption of mechanization will increase crop productivity to 12-34% and it saves 15-20% fertilizer thus, it enhances the income of farmers to 29-49% (Kulakarni 2009). In India, states like Punjab, Haryana and UP are highly mechanized (Ministry of Agriculture & Farmers Welfare 2018). Farm mechanization not only reduces the time in agriculture it is also essential to enhance the input use adeptness with production and productivity. At the global level Brazil, China, Russia, Western Europe and the United States of America reached a mechanization level of about 75, 59.5, 80, 95 and 95 respectively (Fang 2017; Grant 2017). In this case, India attained only 40% mechanization (Mehta et al. 2019). In India, in terms of farm mechanization Haryana, Punjab and Uttar Pradesh are leading states whereas north-eastern states are lagging. In farm mechanization tractor usage has been increasing whereas usage of other farm implements are lagging (Modi et al. 2020). Usage of mechanization in various farm activities such as seed bed preparation, weeding and intercultural operations, irrigation, nutrient management, plant protection and harvesting and threshing are the best climate-smart technology (Modi et al. 2020).

Soil Health Card

This scheme is being implemented through the Department of Agriculture of all the States and Union Territory governments and promoted by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers' Welfare. An SHC is meant to give each farmer the soil nutrient status of his/her agricultural land and give advice to them on the dosage of fertilizers, the needed soil adjustments, which should apply to maintain soil health in the long run. Soil health and nutrient management are the salient features of this programme.

The impact evaluation conducted by Reddy (2017) reports that the overall coverage of SHC is satisfactory. This report also pointed out that, much more attention should be given towards the quality of soil sample collection and testing and also timely distribution of SHCs to the farmers. However, a few states like Andhra Pradesh, Chhattisgarh, Karnataka, Maharashtra, Tamil Nadu, Telangana and Uttar Pradesh were performing well as compared to other

states. In phase-1, 100% target was achieved concerning sample collection, in soil testing 93% target was achieved; whereas, only 80% target was achieved in Soil Health Card printing (Rakshit 2019).

National e-Governance Plan (Ne-GPA)

The mission of e-Kranti is to ensure a Government wide transformation by delivering all Government services electronically to the citizens through integrated and interoperable systems via multiple modes while ensuring efficiency, transparency and reliability of such services at affordable costs. The objective of this programme is to redefine NeGP with transformational and outcome-oriented e-Governance initiatives and to enhance the portfolio of citizen-centric services. This programme would facilitate farmers to get real-time price information, online ordering of inputs and online cash, loan, and relief payment with mobile banking (Digital India Online).

Pradhan Mantri Fasal Bima Yojana (PMFBY)

The aim of Pradhan Mantri Fasal Bima Yojana (PMFBY) is to support the sustainable production of the agriculture sector. Low premium rates for farmers, use of technology, better coverage and increased awareness are the salient features of this scheme. Insurance for agricultural damages in different stages of the crop(s) is the main aim of this scheme.

This scheme covers the following risks:

- Prevented Sowing/ Planting Risk due to deficit rainfall or adverse seasonal conditions
- Yield loss in standing crop (any time during sowing to harvesting) due to adverse risks, such as drought, dry spells, flood, inundation, landslides, natural fire, lightning, storm, hailstorm, cyclone, typhoon, hurricane, tornado, pests and diseases.
- Post-Harvest Losses (up to a maximum period of two weeks from harvesting only for crops which allowed to dry and spread condition in the field) due to specific risks of cyclone and cyclonic rains and unseasonal rains.
- Localised Calamities due to localised risks of hailstorms, landslides, and inundation affecting isolated farms in the specific area.

Note: Losses arising out of war and nuclear risks, malicious damage and other preventable risks shall be excluded from this scheme.

All the farmers availing loans (farmer's availed loan for seasonal agriculture purposes from financial institutions for the selected crops) would be compulsorily covered under this scheme. However, this scheme is optional for non-loaned farmers (PMFBY Online). Under this scheme, coverage of agricultural insurance has significantly increased over some time (DTE 2017). Before 2020, farmers needed to take loans from banks, but from 2020 it was made optional for the farmers. In voluntary regime, the PMFBY scheme has declined by 30 per cent and the premium has increased to 2-3 per cent (Singh 2009). In 2019, budgetary provision for crop insurance was Rs. 16.95 billion which was increased to Rs. 156.95billion for the year 2020 (Tyagi 2020). PMFBY 2020 reports show that, the benefit ratio of Kerala shows 72 per cent benefit ratio followed by Karnataka 49%, Andhra Pradesh 47%, Tamil Nadu 40%, whereas the benefit ratio was low in Jharkhand and Bihar with 7% and 8% respectively. A study conducted by Tiwari et al. (2020) highlighted, delays in claim settlements, bureaucratic inefficiencies, and complexity in procedures are keeping farmers away from coming forward to obtain crop insurance.

National Innovations on Climate-Resilient Agriculture (NICRA)

To face the challenges of climate change, the Indian Council for Agriculture Research (ICAR) launched a network project National Innovations on Climate-Resilient Agriculture (NICRA) in 2011. The project aims to develop and promote climate-resilient technologies in agriculture particularly in vulnerable areas for extreme events of the country. Strategic research, technology demonstration, capacity building and sponsored/competitive grants are the major components of this project. The objectives of the project are 1) to enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through the development and application of improved production and risk management technologies. 2) to demonstrate site-specific technology packages on farmers' fields for adapting to current climate risks. 3) to enhance capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

A district level risk assessment of agriculture to climate change for 572 rural districts was prepared

to address the foremost vulnerabilities in the country. Climate-resilience was brought in agriculture by introducing various Climate-Resilient Technologies (CRTs) such as climate-smart crop varieties/abiotic stress tolerant varieties, livestock breeds and different management practices. Indian Council for Agriculture Research (ICAR) along with National Agriculture Research System (NARS) has prepared District Agriculture Contingency Plans (DACPs) for 650 districts of the country and is being updated regularly (NICRA online). To increase the adaptive capacity of the farmers to cope with the changing climatic conditions, various location-specific proven technologies demonstrations are being implemented in an area of about 2 lakh ha of 446 villages in 28 states of the country (Gupta et al. 2019).

As part of the NICRA project, various climate-resilient /climate-smart technologies were demonstrated in different parts of India. Following are the few examples for such technologies:- In-situ moisture conservation under zero tillage, low-cost water harvesting structure –*Jalkund*, Integrated farming system (Paddy and Fish) in Umjalaesiaw village of Meghalaya; artificial recharge wells, Custom Hiring Centre in Jalna, Maharastra; rainwater harvesting systems in Bhalot Village of Kutch, Gujarat; intercropping systems (maize + redgram) in dryland region of Gadag district of Karnataka (http://www.nicra-icar.in/nicrarevised/index.php/ publications/ success-stories). However, few interventions such as solar lift irrigation systems have both positive and negative impacts on income and resources. On one hand, the solar water pumps have the potential of massive benefits to the farmers by reducing average electricity consumption, increasing security by increasing cropping intensity also helping in increasing the annual profits of the farmers (Gupta 2019). On the other hand, solar water pumps have a negative impact on the ground water table (Strand 2010, Bassi 2018, Bhattacharyya et al. 2020).

RECENT AGRICULTURE POLICIES AND CLIMATE-SMART AGRICULTURE

To enhance the farmer's income by reducing input costs and also to enhance the resilience towards extreme events, the GoI launched several policies, programmes and schemes. Among them most of the policies have been found to be directly and indirectly associated with CSA. Various interventions implemented under different programmes, schemes and policies by the GoI under four components of CSA (production system, non-farming actions, institutional and financial support) are described and presented in Table 2.

Management practices of CSA and Government Policies, Schemes and Programmes

Different management practices such as crop management, water management, soil management, nutrient management, risk reduction, technology and capacity-building interventions are the major key components of CSA. All the CSA components are an integral part of selected policies, schemes and programmes. The details on policies, schemes and programmes and their co-ordination with management practices of CSA are presented in Table 3.

Crop Management

Crop management contributes significantly to the production, resilience and mitigation of climate-smart agriculture (CSA) component. Crop management contributes to effective crop establishment practices and food security which contributes to the reduction of greenhouse gas (GHG) emissions (Briscoe and Malik 2006). Sustainable crop management practices can be implemented through RKVY-RAFTAAR, NFSM, NMSA policies and schemes.

Water Management

Water management is one of the prominent management practices in CSA. However, climate projections and observed data show that changes in water quality and quantity due to climate change negatively affect crop production thus, putting small and marginal farmers on the verge of vulnerability (FAO 2016). Particularly this scenario would be observed in drylands arid and semi-arid landscapes (Nautiyal 2015). To overcome this issue, farmers need to adopt sustainable water management practices such as drip irrigation, sprinkler irrigation, construction of farm ponds and rain water harvesting through PMKSY.

Soil Management

Soils have a high potential to store carbon in it. With appropriate CSA practices soil organic carbon can be restored, conserved and increased at the landscape

Table 2. Policies/ programmes under four components of Climate-Smart Agriculture (CSA)

Policies	Year	Actions/ Interventions
CSA component- Production System		
Soil Health Card	2015	Soil health and nutrient management
Pradhan Mantri Krishi Sinchai Yojana (PMKSY)	2015	Irrigation and watershed development
Paramparagat Krishi Vikas Yojana (PKVY)	2015	Organic farming, soil health management and Integrated Manure Management (IMM)
National Mission for Sustainable Agriculture (NMSA)	2014-15	Development of rain-fed agriculture, Integrated Farming Systems (IFS), Water use and management, increasing water holding capacity, Integrated Nutrient Management (INM) practices and on farm & off farm resource conservation technologies.
National Mission on agricultural Extension and Technology (NMAET)	2014	Agriculture mechanization, plant protection and plant quarantine and distribution of seed and planting material.
Sub-mission on Agro forestry (SMAF)	2014	Biodiversity conservation, agro biodiversity and CC mitigation
National Food Security Mission (NFSM)	2007	Additional food grain production and seed conservation
Rastriya Krishi Vikas Yojana (RKVY) – 2007	2007	Soil health, pest management, farm mechanization, horticulture and sericulture development, preservation of seeds, soil and nutrient management, water use and management, integrated development of food crops, technology and biodiversity conservation.
National e-Governance Plan (Ne-GPA)	2006	To make use of technological intervention such as weather reports and new technological models
CSA component- Non-farming actions		
Sub-mission on Agro forestry (SMAF)	2014	Livelihoods and livestock development
Rastriya Krishi Vikas Yojana (RKVY)	2007	Animal husbandry, dairy production and fisheries
CSA component- Institutional Support		
Paramparagat Krishi Vikas Yojana (PKVY)	2015	Certification of organic products
National Mission for Sustainable Agriculture (NMSA)	2014-15	Preparation of location specific planning and Dissemination and adaptation of rain-fed technologies in disadvantaged areas
National Mission on agricultural Extension and Technology (NMAET)	2014	Extension and dissemination of technology information through various institutions.
Rastriya Krishi Vikas Yojana (RKVY)	2007	Preparation of state and district agriculture plans, Agriculture research, extension services to farmers and study tours for farmers.
National e-Governance Plan (Ne-GPA)	2006	Information and Communication on new technologies and Online ordering inputs.
CSA component- Financial Support		
Pradhan Mantri Kisan Samman Nidhi (PM-Kisan)	2019	Support Financial needs of farmers to procure various inputs.
Pradhan Mantri Fasal Bima Yojana (PMFBY)	2016	Insurance for agricultural damages in different types of crop(s).
Paramparagat Krishi Vikas Yojana (PKVY)	2015	Financial support for organic farming
Sub-mission on Agro forestry (SMAF)	2014	Increasing income levels of farmers through nurseries and other agroforestry practices.
Rastriya Krishi Vikas Yojana (RKVY)	2007	Increasing the income levels of the farmers and agricultural marketing.
National e-Governance Plan (Ne-GPA)	2006	DBT, real time price information, online cash transfer and relief payment

level (Corsi et al. 2012). This OC plays a major role in maintaining the soil quality. Unsustainable land management practices such as improper application of fertilizers, simplified crop rotations, tillage-based crop production systems, simplified crop rotations, inappropriate irrigation practices, disorganized grazing methods and over exploitation of forest lands which can lead to soil nutrient mining (FAO 2013). Keeping this in view the Government of India launched the soil health card scheme in 2015 to assess the soil quality of every agricultural land. Beside this, other schemes, NFSM (Restoration of Soil Fertility), NMSA (Soil Health Card), and PKVY (Organic Farming) schemes are supporting the soil management practices (Micro-dosing precision farming, soil aeration with organic manure, mulching

Table 3. Central government policies and programmes and their co-ordination with various components of CSA

Programme / Policy	Crop	Water management	Soil management	Nutrient management	Risk management	Technology reduction	Capacity Building	Alignment to CSA Pillars
RKVY-RAFTAAR	Crop diversification	Micro Irrigation		INM	-	-	-	P, R, M
NFSM	Crop conservation		Restoration of soil fertility	INM	-	Machineries (Resource conservative)	Farmers training	P, R, M
NMSA	Location specific Integrated/composite farming systems	Water management	Soil health card	Judicious use of fertilizers	-	Rain fed technologies	Farmers training	P, R, M
PMKSY	-	Micro Irrigation	-	-	-	-	Capacity Building	P, M
PKVY	-	-	Organic farming	Organic farming	-	-	-	P, M
NMAET	-	-	-	-	-	Farm mechanization	Farmer driven and farmer accountable extension system	P, R, M
SHC	-	-	Soil management	Nutrient management	-	-	-	P, R, M
Ne-GPA	-	-	-	-	-	Optimum usage of technology	-	R
PMFBY	-	-	-	-	Insurance		-	R

P: Production; R: Resilience; M: Mitigation

and providing and promoting of organic fertilizers).

Nutrient Management

Nutrient management is one of the key components in CSA practices. Nutrient management is required to optimize the plant production in yield and profit, resource conservation, efficiently improve nutrient usage and enhance soil quality and production. To have proper nutrient management there is a need for Integrating Nutrient Management (INM) practices in agriculture. There are various schemes and policies such as RKVY-RAFTAAR, NFSM, NMSA, PKVY and soil health cards promoting nutrient management practices by aligning the three pillars of the CSA.

Risk Reduction

Income from agriculture is uncertain due to various risk factors such as pest attacks, extreme events and instability in markets. In general, the common wisdom of a human is proportional to income and the same can be observed in agriculture too. A farmer invests in agriculture inputs every month, but harvesting and income generation will happen only twice or thrice in a year (Ghate and Reddy 2019). However, due to various uncertain events farmers may not get timely and sufficient returns from agriculture. To reduce the risk of farmers, GoI has launched PMFBY in 2016. Under this scheme, farmer will get compensation for crop losses due to drought, flood, pest attack, etc. This farm insurance also covers asset damage and farmers accidents. Particularly, under the horticulture mission farmers will get strong insurance packages with good compensation. Apart from PMFBY, farmers can also avail insurance (Digital Compensation Disbursal) from Weather Based Crop Insurance Scheme (WBCIS) at the regional level, when the district collector announces the crop yield loss during extreme events and pest attacks (Ghate and Reddy 2019).

Technology Management

Climate driven technologies play a major role in CSA practices. These technologies include resource conservative machinery, rain-fed technologies, farm mechanization and weather based agro advisory services. NFSM promotes the usage of resource conservative machines by the farmers, Similarly, NMSA promotes the usage of rainfed technologies and NMAET promotes farm mechanization.

Table 4. Selected cased studies under different components of CSA

CSA Component	Place	Action	Impact	Beneficiaries	Reference
Production system and non-farming activities	KVK, Rudrur, Nizamabad District Telangana	Implementation of mechanization and Back yard poultry through RKVY	Yield of Maize and sugar cane increased. Additional Income from poultry (monthly income from BYP 2000/-)	Farmers and SHG women	Veni et al. 2018
Production system	West Bengal	Zero Budget Natural Farming and Organic Farming under PKVY	Cost of cultivation has reduced	Farmers	Koner and Laha 2021
Production system	Srikakulam District, Andhra Pradesh	Watershed development under PMKSY scheme	Productivity of maize (2866 kg/ha to 3578 kg/ha), rice (3744 kg/ha to 4413 kg/ha) and green gram (326 kg/ ha to 400 kg/ ha) crops has increased	Farmers	Basha et al. 2019
Production system	Satna District, Madhya Pradesh	Protective irrigation and Integrated water management practices	52.33 % wheat production/acre has increased. Returns also increased.	Farmers	Suryavanshi and Gupta 2020
Non-farming activities	Chittoor District, Andhra Pradesh	Support for Sheep rearing through RKVY	Positive impact on income. Economic inequality has reduced among sheep rearing community	Sheep rearing community	Vamsi et al. 2019
Non-farming activities	Chhattisgarh	Support for fisheries development through RKVY	30.97% growth rate observed in fishery	Fish farming group	Bhendarkar et al. 2017
Institutional support	Indo-Gangetic Plains of Uttar Pradesh	Bi-priming technology has been distributed through extension activities through RKVY Programmes	Efficient usage of nutrients and sustainable improvement of crop yield.	Farmers	Rakshit 2019
Institutional Support	Bihar	Implementation of Strategic Research and Extension Plan of Agricultural Technology Management Agency	17.72 % increase in crop diversification. Area under oil seeds, vegetables, cereals and pulses has increased	Farmers	Singh et al. 2016
Financial Support	Uttar Pradesh	Financial support to the farmers to procure agri inputs through Pradhan Mantri Kisan Samman Nidhi (PM-Kisan)	Increased the adoption of modern technologies (cultivars) through KVK	KVK beneficiaries (Farmers)	Varshney et al. 2020
Financial and	Though out the country	Financial and institutional support to develop the organic farming and certifying their orducts through Paramparagat Krishi Vikas Yojana (PKVY)	Reduction in the cost of cultivation (10 to 20%) from shops. With this increase beneficiaries net returns increased to 20 to 50%	Registered farmers under this scheme	Reddy 2017

Capacity Building

There is a need for knowledge and idea on both adaptation and mitigation fronts to enable the farmers to face the challenges driven by climate and other factors in agriculture. Farmers should gain knowledge on every CSA intervention which are necessary to increase their income and agriculture productivity. For this, there is a need to increase the capacity building of farmers regarding new and recent interventions by training programmes and workshops. Capacity building programmes can be organized for the farmers under the NFSM, NMSA, PMKSY, NMAET policies and schemes.

CROSS SECTORAL POLICIES

National Environment Policy 2006

The National Environment Policy (NEP) - 2006 was an effort towards India's assurance to clean environment and making a progressive contribution to international efforts with respect to environmental concerns. NEP was built on the different existing policies such as National Forest Policy, 1988; National Conservation Strategy and Policy Statement on Environment and Development, 1992; and Policy Statement on Abatement of Pollution,1992; National Agriculture Policy, 2000; National Population Policy, 2000; National Water Policy, 2002. The objectives of this policy includes conservation of critical environmental resources; Intra-generational equity; integration of environmental concerns in economic and social development; efficiency in environmental resource use; environmental governance; enhancement of resources for environmental conservation (NEP 2006). In the view of agriculture this policy will focus on reducing GHG emissions from crops, usage of clean energy technologies and increasing soil fertility by reducing pollutants. Regarding agriculture, with respect to the ground water table, NEP suggests only promotional actions, such as moisture conservation, intensive water expanding green cover, reviving the agronomic practices, promotional agriculture practices. However, it did not address the issues of different institutional forms and rights that need to be designed to enable access to ownership of natural resource dependent people in a sustainable way (Singh 2009).

National Forest Policy 1988 (NFP)

The NFP was enacted with the following major objectives: restoration of the ecological balance and maintenance of environmental stability. Though this policy is directly connected to the forest, it also supports agriculture development by giving importance to soil and water conservation and siltation in reservoirs to mitigate floods and droughts (NFP 1988). There was no CSA component during 1988 when the Government of India launched NFP. However, in NFP, more emphasis was given to environment related and natural resource management practices such as soil and water conservation, farm forestry and sustainable resource utilization in this policy.

National Agroforestry Policy 2014

The National Agroforestry Policy was enacted to enhance profitability, productivity, sustainability and diversity of ecosystems in rural landscape. This policy initiative includes different policies viz. the National Forest Policy 1988, the National Agriculture Policy 2000, Planning Commission Task Force on Greening India 2001, National Bamboo Mission 2002, National Policy on Farmers, 2007 and Green India Mission 2010. The basic objectives of this policy are 1) Protect and stabilise ecosystems, and promote resilient cropping and farming systems to minimize the risk during extreme climatic events. 2) Encourage and expand tree plantation in complementarity and integrated manner with crops and livestock to improve productivity, employment, income and livelihoods of rural households, especially small holder farmers. 3) Supplement the availability of agroforestry products (AFPs), such as the fuel-wood, fodder, non-timber forest produce and small timber of the rural and tribal populations, thereby reducing the pressure on existing forests. 4) Meet the raw material requirements of wood based industries and reduce import of wood and wood products to save foreign exchange. 5) Develop capacity and strengthen research in agroforestry and create a massive people's movement for achieving these objectives and to minimize pressure on existing forests. 6) Complement achieving the target of increasing forest/tree cover to promote ecological stability, especially in the vulnerable regions (MoFDEA 2021). In the view of agriculture, this policy emphasises efficient nutrient cycling, organic

matter addition for sustainable agriculture and for improving vegetation cover.

Disaster Management Policy 2009

Climate change impacts various aspects such as water balance, glacial reserves, coastal ecology, forestry, agriculture, human and animal health and biodiversity. There are also indications that climate change would upsurge the intensity and frequency of disasters like droughts, floods and cyclones in the coming years. To face these challenges in an effectively and sustainably the Government of India launched Disaster Management Policy in the year of 2009. As per DMP 2009, to meet climate change challenges in a sustained and effective way, interactions in our method and strategies for climate change adaptation and disaster risk reduction shall be encouraged and promoted through various climate-smart actions such as early warning system, strengthening emergency operation centres, community based disaster preparedness and Corporate Social Responsibility (CSR) and Public-private Partnership (PPP) (NDMA 2009).

National Agriculture Disaster Management Plan (NADMP)

The Union agriculture ministry prepared a disaster management plan to provide timely help to respond to natural disasters such as floods and droughts. Under the plan, italso includs pandemic events such as novel coronavirus disease. So far only drought and floods are linked in disaster management plan in the context of agriculture. However, in this plan, 34 hazards have been identified which are posing risks to the agriculture sector with the objective of a multi hazard plan (the National Agriculture Disaster Management Plan (NADMP). As part of this plan, appropriate measures can be taken to prevent dangers before they turn into disasters by adopting long, medium and short term measures. The plan also includes a hazard risk vulnerability analysis which focuses on region-specific hazards. Zones will be identified based on agro-climatic conditions defined by NITI-Ayog.

Review of Impact of different Policies/programmes and schemes in India

In India, several policies have been implemented to increase agriculture productivity, economic status of stake holders and reduce the financial burden in their activities. In a diversified country like India, different factors such as social, political and ecological are the controlling points to achieve the targets/goals of policies/schemes/programmes. However, due to appropriate setups (departments, KVKs and other line departments) at the ground level, it has become easy to implement the schemes/policies / programmes in a very effective way. To showcase this, a few selected case studies under different components of CSA are presented in Table 4. With this evidences, it is clear that policies are effectively working at the ground level to enhance the agriculture productivity, livelihoods and income in ground level in India which help achieving all the four CSA components. In this paper, we also tried to capture negative impacts from the ground level after implementing policies/schemes and programmes by reviewing the literature. However, we were not able to identify the literature related to the negative impacts of these policies.

CONCLUSIONS

India is one of the developing nations in the world where agriculture is the primary livelihood option for a majority of the population. Though the contribution to the GDP from the agriculture sector is decreasing, a maximum number of people in rural areas are still depending on agriculture to make a livelihood. However, the increasing extreme events such as floods and drought have an adverse impact on the agriculture sector. Small, marginal and medium farmers are most vulnerable to the changing climate. To overcome this issue, in recent years the Government of India has launched or restructured various new agriculture policies and schemes to combat the extreme events of climate change issues affecting the farmers. Every programme is implemented based on a set of guidelines and through separate managerial and institutional arrangements. Most of the policies and schemes are promoting higher crop productivity and resilience towards extreme events by introducing climate-smart practices in agriculture. For this, substantial funds have been allocated annually for increasing productivity and making the agriculture sector more climate resistant. Under these schemes, various farm practices such as crop management, water management, soil management, nutrient

management, weather based agro-advisory services, technological interventions and capacity building are promoted. To achieve the objectives of CSA, there is a need of creating Climate-Smart Farmers (CSF) and a holistic Climate-Smart Village (CSV) by providing timely awareness and inputs through training to farmers.

The Government of India has implemented various farm level initiatives which directly align with CSA through different programmes to enhance agriculture production and productivity. Nevertheless, a huge gap has to be bridged to enhance farm mechanization, crop residue management, awareness and access to technology. Scientific validation of traditional knowledge in agriculture in adapting to changing climate has not been given deserving importance in the existing policy arena. These practices are to be scientifically validated, knowledge exchange and easy proliferation for scalable adoption must be initiated. Farm mechanization is one of the key components of CSA. In India, as part of farm mechanization, tractors penetration is high as compared to other agriculture implements. In India, farm size is a major barrier to implementing farm mechanization effectively. This is because small and marginal farmers have more than 45% of the land area. Though this small and marginal group is highly vulnerable to climate change and other external factors, they are still not able to adopt technological interventions in their fields due to small patches of land and high prices of machinery etc. However, this problem could be solved by community management practices with the help of local implementing agencies (Panchayats, KVK and Agriculture department).

Gaps

Future development of policies or restructuring of old policy should be formulated keeping in mind farm mechanization and more emphasis laid on sustainable resource use. Crop residue management is another crucial and key component in CSA that needs to be given more weightage in current agriculture programmes. Several training programmes and awareness programmes have already been conducted by agriculture departments and other line departments and institutions on various issues to the farmers. However, a streamlined mechanism should be developed for the dissemination of knowledge and information from the scientific and policy domains to farmers even. Though most of the sustainable agriculture technologies evolved from (Indigenous Traditional Knowledge (ITK) practices [(Mishra et al. 2020). However, it has been proven that, traditional knowledge has been given less attention in agriculture policies. Scientific validation of traditional knowledge to mainstream ideas in CSA is lacking in most of the policies. Hence, identifying and mainstreaming traditional and proven practices/ technologies, knowledge exchange mechanisms in a more formalized and efficient manner by localized action, institutional restructuring for implementation and monitoring mechanisms for participatory actions are required to achieve the objectives of CSA.

Recommendations and way forward

With the above observations and gaps in this paper we are recommending the following:

- Farm mechanization should be given more weightage. All farm level machinery should be made available to small and marginal farmers. Farm-level machinery should be supplied at the ground level based on the farming activities besides proper training must be given to the communities for effective usage of implements.
- Specific policies and programmes should be made to the management of crops at the field level.
- There is a need for more area specific hands on training for farmers on various management practices of CSA at the ground level.
- Location specific policies should be framed to easy implementation and to full fill the requirements of farmers.
- Proper management mechanisms should be made to evaluate and asses the progress of various programmes related to CSA at the village level.

Conflict of Interest: The authors declare that there is no conflict of interest

Authors contributions: SN and AKG conceptualised the study, supervised and finalised the manuscript. YDIK, MG, SP and SB collated in the information, analysed the data and prepared the manuscript.

REFERENCES

Amadu, F.O., Paul, EMc. and Daniel, CM. 2020. Yield effects of climate-smart agriculture aid investment in Southern Malawi. Food Policy, 92, 101869. https://doi.org/10.1016/j.foodpol.2020.101869

Arnell, N.W., Lowe, J.A., Bernie, D., Nicholls, R.J., Brown, Challinor, A.J. and Osborn, T.J. 2019. The global and regional impacts of climate change under representative concentration pathway forcings and shared socio-economic pathway socioeconomic scenarios. Environmental Research Letters, 14(8), 084046.

Basha, P.R., Prasad, M.S., Rao, S.V.N., Rekha, D.V.S.R.L. and Mahesh, B. 2019. Impact of batch-I (2009-10) PMKSY–watersheds programme on cropping pattern, crop yields and household income in Srikakulam District of Andhra Pradesh. Journal of Research ANGRAU, 47(1), 57-63.

Bassi, N. 2018. Solarizing groundwater irrigation in India: A growing debate. International Journal of Water Resources Development, 34 (1), 132–145.

Bhalla, G.S. 2007. Indian Agriculture Since Independence. National Book Trust, Delhi. 348pp.

Bhattacharyya, P., Pathak, H. and Pal, S. 2020. Climate-Smart Agriculture: Concepts, challenges, and opportunities. Springer Nature.

Bhendarkar, M.P., Sundaray, J.K., Ananth, P.N. and Pradhan, S. 2017. Aquaculture development in Chhattisgarh, India: What, why and how? International Journal of Fisheries and Aquatic Studies, 5(4), 272-278.

Briscoe, J. and Malik, R.P.S. 2006. India's Water Economy: Bracing for a Turbulent Future. Oxford University Press, New Delhi.

Corsi, S., Friedrich, T., Kassam, A., Pisante, M. and de Moraes Sà J.C. 2012. Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture: A literature review. Integrated Crop Management, 16, AGP/FAO, Rome, 101.

Cradock-Henry, N.A., Blackett, P., Hall, M., Johnstone, P., Teixeira, E. and Wreford, A. 2020. Climate adaptation pathways for agriculture: Insights from a participatory process. Environmental Science & Policy, 107, 66-79.

Digital India, (online). https://digitalindia.gov.in/. Accessed on March 2, 2021.

DTE. 2017. Pradhan Mantri Fasal Bima Yojana is a good scheme with flawed execution, says CSE. https://www.downtoearth.org.in/news/agriculture/pradhan-mantri-fasal-bima-yojana-is-a-good-scheme-with-flawed-executive-says-cse-58330. Accessed on March 2, 2021.

Fang, C. 2017. Development of agricultural mechanization in China. https://forum2017.iamo. de/microsites/forum2017.iamo.de/leadmin/presentations/B5_Fang.pdf. Accessed on February 18, 2021.

FAO. (Food and Agriculture Organization) of the United Nations). 2018. The Future of Food and Agriculture: Alternative Pathways to 2050. http://www.fao.org/3/I8429EN/i8429en.pdf. Accessed on April 14, 2020.

FAO. 2013. Climate-Smart Agriculture Source Book. Food and Agriculture Organization of the United Nation, Rome.

FAO. 2016. The state of food and agriculture: Climate change, agriculture and food security. Rome, Italy.

Fishman, R.M. 2011. Climate change, rainfall variability, and adaptation through irrigation: Evidence from Indian agriculture. Job Market Paper.

Fishman, R., Kishore, A., Rothler, Y., Ward, P.S., Jha, S. and Singh, R.K.P. 2016. Can information help reduce imbalanced application of fertilizers in India? Experimental evidence from Bihar. Discussion Paper 1517, International Food Policy Research Institute, Washington, DC.

Ghate, U. and Reddy, K.K. 2019. Agri-Insurance & Credit (Finance). pp. 201-205. In: Srinivasarao, C., Srinivas, T., Rao, R.V.S., Rao, N.S., Vinayagam, S.S. (Eds) Sustainable Livelihoods and Adaptation to Climate Change (SLACC): Training Manual. NIRD&PR, Hyderabad.

Grant, T. 2017. Mechanisation key to higher productivity to double farmers' income. Grant Thornton India LLP.

Gupta, A.K., Hodam, S., Chary, G.R., Prabhakar, M., Sehgal, V.K., Srivastava, R., Swati, S. and Bhardwaj, S. 2019. Roadmap of Resilient Agriculture in India. Thematic paper released on International Symposium on Disaster Resilience and Green Growth for Sustainable Development organized by Centre for Excellence on Climate Change, NIDM, New Delhi (India).

Gupta, E. 2019. The impact of solar water pumps on energy-water-food nexus: Evidence from Rajasthan, India. Energy Policy, 129, 598-609.

IBEF. 2020. Agriculture and allied industries, https://www.ibef.org/download/Agriculture-and-Allied-Industries-November-2020.pdf. India Brand Equity Foundation.

IPCC. Summary for policymakers. Climate Change. 2014. Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. In: Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 1-32

Jain, N., Bhatia, A. and Pathak, H. 2014. Emission of air pollutants from crop residue burning in India. Aerosol and Air Quality Research, 14(1):422-430.

Joshi, P.K. 2011. Conservation agriculture: An overview. Indian Journal of Agriculture Economics, 66(1), 53-63.

Khan, Y.D.I., Reddy, K.S. and Mukate, S.V. 2019. Micro Irrigation Systems. pp. 141-154. In: Srinivasarao, C., Srinivas, T., Rao, R.V.S., Rao, N.S., Vinayagam, S.S. (Eds) Sustainable Livelihoods and Adaptation to Climate Change (SLACC): Training Manual. NIRD&PR,Hyderabad.

Khatri-Chhetri, A., Aggarwal, P.K., Joshi, P.K. and Vyas, S. 2017. Farmers' prioritization of climate-smart agriculture (CSA) technologies. Agricultural systems, 151, 184-191.

Kishore, A., Pala, B.D., Joshia, K. and Aggarwal, P.K. 2018. Unfolding government policies towards the development of climate-smart agriculture in India. Agricultural Economics Research Review, 31(347-2018-5153), 123-137.

Koner, N. and Laha, A. 2021. Economics of alternative models of organic farming: empirical evidences from zero budget natural farming and scientific organic farming in West

Bengal, India. International Journal of Agricultural Sustainability, 19(3-4), 255-268.

Kulakarni, S.D. 2009. Mechanization of Agriculture-Indian Scenario. http://www.un-csam.org/Activities%20Files/A09105thTC/PPT/in-doc.pdf. Accessed on January 14, 2021.

Kumar, P., Manjunatha, A.V., Kannan, E., Bhende, M.J., Ramappa, K.B., Singha, K. and Thippiah, P. 2013. Impact evaluation of Rashtriya Krishi Vikas Yojana. ADRTC, Institute for Social and Economic Change, Bengaluru, Karnataka. https://rkvy.nic.in/static/download/pdf/Final_Report_1_ISEC.pdf

Kumar, S., Raizada, A., Biswas, H., Srinivas, S. and Mondal, B. 2016. Application of indicators for identifying climate change vulnerable areas in semi-arid regions of India. Ecological Indicators, 70, 507-517.

Kumar, V. and Ladha, J.K. 2011. Direct seeding of rice: recent developments and future research needs. Advances in Agronomy, 111, 297-413.

Mahdi, S.S. 2019. Climate Change and Agriculture in India: Impact and Adaptation. Springer.

Makadia, J.J., Mistry, H.H. and Kuthe, S.B. 2015. Impact of soil health card on determinants of fertilizer consumption and fertilizer use efficiency in Gujarat, India. Economic Affairs, 60(4), 577.

Makate, C. 2019. Effective scaling of climate-smart agriculture innovations in African smallholder agriculture: A review of approaches, policy and institutional strategy needs. Environmental Science & Policy, 96, 37-51.

Mall, R.K., Gupta, A., Singh, R., Singh, R.S., Rathore, L.S. 2006. Water resources and climate change: An Indian perspective. Current science, 90(12), 1610-1626.

Manjunatha, A.V. and Kumar, P. 2015. Impact of National Food Security Mission (NFSM) on Input use, Production, Yield and Income in Karnataka. Agriculture Development and Rural Transformation Centre Report, Institute for Social and Economic Change, Bengaluru, Karnataka.

Mehta, C.R., Chandel, N.S., Jena, P.C. and Jha, A. 2019. Indian agriculture counting on farm mechanization. Agricultural Mechanization in Asia, Africa and Latin America, 50, 84-89.

Ministry of Agriculture & Farmers Welfare. 2018. Central Sector Scheme on Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi: Operational guidelines. Government of India.

Mishra, A., Singh, S.R.K. and Raut, A.A. 2020. Traditional Knowledge in Agriculture. Division of Agricultural Extension, ICAR, New Delhi-39.

Modi, R.U., Manjunatha, K., Gauam, P.V., Nageshkumar, T., Sanodiya, R., Chaudhary, V. and Rao, C.S. 2020. Climate-smart technology based farm mechanization for enhanced input use efficiency. pp. 257-325. In: Srinivasarao, C., Srinivas, T., Rao, R.V.S., Rao, N.S., Vinayagam, S.S. (Eds) Climate Change and Indian Agriculture: Challenges and Adaptation Strategies, ICAR-NARM, Hyderabad, India.

MoFDEA. 2021. Economic Survey 2020-21, Volume 1. Ministry of Finance Department of Economic Affairs, Economic Division, Government of India.

NAFP. 2014. National Agroforestry Policy 2014. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. https://agricoop.gov.in/sites/default/files/National_agroforestry_policy_2014. pdf. Accessed on 7th March 2021.

Nath, D. 2017-18. Success stories on Climate-Smart Agricultural Practices National Innovations on Climate Resilient Agriculture (NICRA). Senior Scientist and Head, Krishi Vigyan Kendra, Khowai. Publication no. KVK Khowal/2017-18/08.

Nautiyal, S., Bhaskar, K., Khan Y.DI.. 2015. Biodiversity of semiarid landscape. Switzerland: Springer International Publishing.

NDMA. 2009. National Policy on Disaster Management 2009. Ministry of Home Affairs, Government of India.

NEP. 2006. National Environment Policy 2006. Ministry of Environment and forests, Government of India. https://static.vikaspedia.in/media/files_en/energy/policy-support/environment-1/environment-policy.pdf. Accessed on March 7, 2021.

NFP. 1988. National Forest Policy – 1988. Ministry of Environment and Forests, Government of India, New Delhi. https://mpforest.gov.in/img/files/Policy_NFP.pdf. Accessed on 6th March 2021.

NFSM (Online) National Food Security Mission. Ministry of Agriculture and Farmers Welfare. Government of India. https://www.nfsm.gov.in/Default2.aspx. Accessed on March 6, 2021.

NICRA (Online) National Innovations in Climate Resilient Agriculture. http://www.nicra-icar.in/nicrarevised/. Accessed on March 5, 2021.

NMAET (Online) Guidelines for the Centrally Sponsored Scheme "National Mission on Agricultural Extension and Technology (NMAET)" to be implemented during the XII Plan. Retrieved March, 5, 2021 from http://agricoop.nic.in/sites/default/files/Chapter%20on%20NMAET%20for%20all%20Guidelines_0.pdf.

NMSA (Online) National Mission for Sustainable Agriculture. https://nmsa.dac.gov.in/. Retrieved on February 24, 2021.

OECD/ICRIER. 2018. Agricultural Policies in India, OECD Food and Agricultural Reviews, OECD Publishing, Paris. https://doi.org/10.1787/9789264302334-en

Panda, A. 2017. Vulnerability to climate variability and drought among small and marginal farmers: a case study in Odisha, India. Climate and Development, 9(7), 605-617.

Panda, C.K. and Singh, S.R. 2016. Marginal and small farmers' climate change perception and adaptation. International Journal of Agriculture, Environment and Biotechnology, 9(5), 839.

Pathak, H., Bhatia, A. and Jain, N. 2014. Greenhouse gas emission from Indian agriculture: trends, mitigation and policy needs. Approach Paper. Indian Agricultural Research Institute, New Delhi.

PMFBY (Online A) Pradhan Mantri Fasal Bima Yojana. https://pmfby.gov.in/ Accessed on March 1, 2021.

PMKSY (Online) Pradhan Mantri Krishi Sinchai Yojana. https://pmksy.gov.in/. Accessed on February 15, 2021.

PMKSY (online) Pradhan Mantri Krishi Sinchai Yojana. https://pmksy.gov.in/#:~:text=PMKSY%20has%20been%20approved%20for, been%20made%20which%20includes%20Rs. Accessed on February 24, 2021.

Rakshit, A. 2019. Impact assessment of bio priming mediated nutrient use efficiency for climate resilient agriculture. pp. 57-68. In: Climate Change and Agriculture in India: Impact and Adaptation. Springer, Cham.

Ramappa, K.B. and Manjunatha, A.V. 2017. Impact of Neem Coated Urea on Production, Productivity and soil health in India. Agriculture Development and Rural Transformation Centre Report, Institute for Social and Economic Change, Bengaluru, Karnataka. htttp://www.isec.ac.in/NCU-final%20consolidated%20report%2017082017-revised-print.pdf. Accessed on January 7, 2021.

Rao, A.V.M.S., Yadav, S., Vanaja, M. 2019. Climate Change, Variability and Impacts. pp. 1-7. In: Srinivasarao, C., Srinivas, T., Rao, R.V.S., Rao, N.S., Vinayagam, S.S. (Eds) Sustainable Livelihoods and Adaptation to Climate Change (SLACC): Training Manual. NIRD&PR, Hyderabad.

Reddy, A.A. 2017. Impact Study of Soil Health Card Scheme, National Institute of Agricultural Extension Management (MANAGE), Hyderabad-500030, 210pp.

Reddy, K.S. and Mukate, S.V. 2019. Farm Pond: A climate resilient technology for Semi-Arid Tropics (SAT). pp. 135-140. In: Srinivasarao, C., Srinivas, T., Rao, R.V.S., Rao, N.S., Vinayagam, S.S. (Eds) Sustainable Livelihoods and Adaptation to Climate Change (SLACC): Training Manual. NIRD&PR, Hyderabad.

RKVY-RAFTAAR operational guidelines 2017-18 to 2019-20. https://rkvy.nic.in/static/download/pdf/RKVY_14th_Fin._Comm.pdf. Accessed on February 4, 2021.

Sam, A.S., Kumar, R., Kachele, H. and Müller, K. 2017. Vulnerabilities to flood hazards among rural households in India. Natural Hazards, 88(2), 1133-1153.

Singh, D.K., Singh, P. and Padaria, R.N. 2016. Impact of Agricultural Technology Management Agency Programme on Diversification of Cropping System in Bihar. BIOINFOLET-A Quarterly Journal of Life Sciences, 13(2b), 336-340.

Singh, S.P. 2009. India 2006 National Environment Policy Not a Paradigm Shift. View Point. CUTS CITEE. https://www.cuts-citee.org/pdf/VP0109.pdf. Accessed on March 2, 2021.

SMAF. 2016. Sub-mission on agroforestry- Operational Guidelines. Department of Agriculture, cooperation and farmers welfare, GoI.

Strand, J. 2010. The full economic cost of groundwater extraction. The World Bank.

Suryavanshi, R.R. and Gupta, J.K. 2020. Assess the impact of Pradhan Mantri Krishi Sinchayee Yojana on cost, return, production and productivity of Wheat crop in Satna district of Madhya Pradesh. Advances in Agriculture for Doubling of Farmer's Income, 76pp.

Tiwari, R., Chand, K. and Anjum, B. 2020. Crop Insurance in India: A Review of Pradhan Mantri Fasal Bima Yojana (PMFBY), FIIB Business Review. https://doi.org/10.1177/2319714520966084.

Tripathi, A. and Prasad, A.R. 2009. Agricultural development in India since independence: A study on progress, performance, and determinants. Journal of Emerging Knowledge on Emerging Markets, 1(1):63-92

Tyagi, K. 2020. Upyogi Bane Fasal Bima Yojana. Dainik Jagran. https://www.jagran.com/editorial/ apnibaat-crop-insurance-scheme-should-be-seful-insurancecompanies-need-to-establish-credit-among-farmers20004220.html. Accessed February 2, 2021.

Vamsi, K., Prasad, R.M.V., Suresh, J., Ekambaram, B. and Ravi, A. 2019. Impact of RKVY project on income distribution pattern of beneficiaries of sheep Rearers in Chittoor district of Andhra Pradesh. The Pharma Innovation Journal, 8(7), 42-46.

Varshney, D., Joshi, P.K., Roy, D. and Kumar, A. 2020. Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and the adoption of modern agricultural technologies in Uttar Pradesh, India. International Food Policy Research Institute, Rome, 1907pp.

Veni, C.P., Rajkumar, B.V., Kumar, P.V., Manjari, M.B. and Kumar, B.K. 2018. Impact of Success Cases under RKVY Scheme at Krishi Vigyan Kendra, Rudrur, Nizamabad District, India. International Journal of Current Microbiology Application Science, 7(10), 2661-2669.

Wani, S.P., Chander, G. and Anantha, K.H. 2017. Enhancing resource use efficiency through soil management for improving livelihoods. pp. 413-451. In: Adaptive Soil Management: From theory to practices. Springer, Singapore.

World Bank. 2019. Climate-Smart Agriculture. https://www.worldbank.org/en/topic/climate-smart-agriculture. Accessed on January 25, 2021.

Received:21st September 2021
Accepted:7th July 2022