Institutional context of soil information in India

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CHAPTER I

India supports approximately 17% of the global population and 11% of the world's livestock population on just 2.5% of the world's geographical area, putting immense pressure on its agricultural land. About 43% of its total geographical area is under cultivation and agriculture plays a vital role in the Indian economy. Over 70% of rural households depend on agriculture as their principal means of livelihood. By 2025, India will have to annually produce 300 million t of food grains (compared to the production of about 265 million t in 2013–2014 (ICAR 2015)) or an additional 35 million tonnes (t) of food grains on an even smaller area; the area under food grains declined from 124 million ha in 2007–2008 to 121 million ha in 2009–2010 (DAC 2011) due to the ever-increasing demand for non-agricultural uses.

Main problems in Indian agriculture

There is a wide gap between the potential yield of food crops and the yields attained at the farm level due to: the erratic behaviour of the monsoon, low rainfall in semi-arid and arid regions, high rainfall in Himalayan and Western Ghat regions (leading to high soil erosion), small and fragmented landholdings, non-availability of quality seeds of all crops (especially to small and marginal farmers), low adoption of farm mechanization, and inadequate transportation, storage, marketing and credit facilities. However, land degradation is the biggest threat to food and environmental security in India. Chemical fertilizer consumption is also a matter of concern with imbalanced fertilization and a deficit of micronutrients, organic carbon and soil biomes. Meanwhile, the net sown area has reduced from 143 million ha in 1990–1991 to 140 million ha in 2009–2010 (DAC 2015) due to an increase in land area under non-agricultural uses; the gross cropped area has increased from 186 million ha to 192 million ha due to an increase in cropping intensity. Further, permanent loss of land fit for agriculture due to the conversion of land for non-agricultural uses has put the available agricultural land under tremendous pressure. In addition to rising populations and projected food gaps, the major concerns associated with the future of rain-fed agriculture in semi-arid India include decreasing yield growth and yields, negative nutrient balances and sustainability (Bhalla et al. 1999).

Average farm holding size declined from 2.26 ha in 1970–1971 to 1.6 ha in 2010–2011 and the number of farm holdings increased from 71 million to 137.8 million during the same period mainly due to progressive fragmentation of landholdings. If the same trend continues, farm holdings in 2020–2021 would be around 154 million with the small and marginal holdings accounting for almost 85% of the total holdings and average landholding size projected to decline to just 1 ha (Ganeshamurthy 2014). Green revolution gains in agricultural productivity, food security and reduced poverty were widely associated with irrigated areas, where the benefits of improved seeds and increased use of inorganic fertilizers could be realized. However, there is less potential for expansion of irrigated agriculture as it is increasingly expensive to bring new land under irrigation – water resources are limited and there are widespread problems associated with over-exploitation of groundwater. Under the above circumstances, soil health management (SHM) has a key role to play in sustaining the agricultural sector in the country.

1.1. Objectives of the Study

- To study the institutional context of soil information in India, research, investments, training and extension systems and produce a report with focus on Madhya Pradesh and Maharashtra states
- To offer insights into the status of soil sampling, nutrient analysis, the fertilizer availability scenario and constraints associated with it, governmental advisory and extension services, training and awareness activities taken up by the government institutions
- To give a broad understanding of the implementation of relevant government programmes and activities and whether two states under the study conform to the national plans
- To study the role played by the private players in the above context

1.2. Scope

The study has attempted to broadly analyse the institutional context within which soil research, management and extension take place in India by studying various programmes that are being implemented by the Government of India (GOI), state agricultural departments of Madhya Pradesh (MP) and Maharashtra and the Indian Council of Agricultural Research (ICAR) system. The analysis tries to throw light on whether soil fertility and degradation issues appear in national policy and strategy documents, how the two states under study may or may not integrate soils into overall agricultural planning, and how much difference may be there per state when they conform to the national plans. Key issues such as soil testing and SHM, inorganic fertilizer availability, extension services, training, knowledge availability-updating and sharing, innovative initiatives and adoption of sustainable agriculture are discussed to understand the status of the institutional framework and the capacity of agricultural entities to promote SHM.

1.3. Methodology

The study consists of four components: literature and policy review (for providing the background information and conceptual framework); secondary data collection from studying annual reports; policy briefs; and official websites and information obtained either from the concerned organizations officially or individuals working in those organizations through interviews and interactions and report writing. Available agricultural statistics has been examined keeping the context in mind. Discussions were held with administrators, academicians, scientists, CSOs etc. to get a broad understanding of policy focus on the subject, the activities of training and extension and constraints being faced at present in implementing related government programmes effectively.

1.4. Description

Land utilization pattern, rainfall pattern and agro-climatic zones apart from available water for irrigation give an indication of the soils that are useful for cultivation of different crops. Madhya Pradesh (MP) is the second biggest state in area and fifth largest state in terms of population, accounting for 11% of total net sown area of the country, while Maharashtra is third biggest state in the area and the second biggest in terms of population, accounting for 12% of total net sown area of the country.

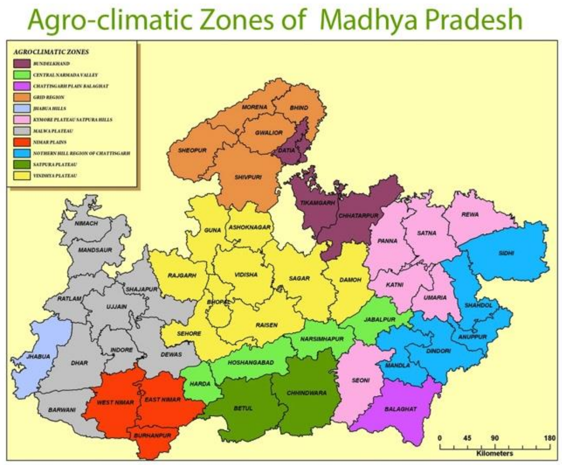
Table 1. Demographic Features and Land Utilization Pattern

Particulars	India	Madhya Pradesh	Maharashtra
Population	1,210,569,573	72,626,809	112,374,333
No. of households	249,454,252	15,093,256	24,421,519
No. of farming households	130 million	7.8 million	13.7 million
Total geographical area (000 ha)	328,726	30,825	30,771
Forests (000 ha)	70,006	8,697	5,216
Net area sown (000 ha)	141,579	15,119	17,406
Area sown more than once (000 ha)	57,390	6,926	6,663
Total cropped area (000 ha)	198,969	22,046	24,069
Net irrigated area (000 ha)	63,601	7,140	3,256
Gross irrigated area (000 ha)	89,360	7,420	4,850
Cropping intensity (%)	137.0	147.8	126.1

Source: Census of GOI, 2011 and Agriculture statistics 2011

1.4.1. Agro-climatic zones

There are 127 agro-climatic zones in India. MP is divided into 11 agro-climatic zones while Maharashtra is delineated into nine agro-climatic zones.



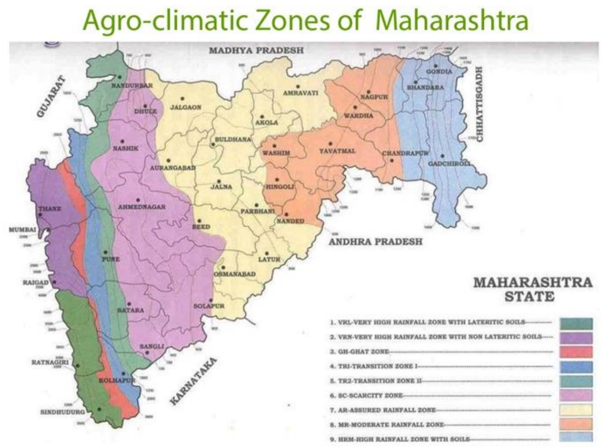


Figure 1 Agro Climatic Zones

Figure 1. Agro-climatic zones of Madhya Pradesh and Maharashtra.
Source: remote-sensingandgis.blogspot.com and www.mahaiwmp.gov.in

The average annual rainfall of the country is about 1,186 mm with wide variation (as high as 10,000 mm per year in the north-east to as low as 100 mm in the desert areas of Rajasthan) with nearly 75% of rainfall being received during the monsoon season. Annual rainfall in MP varies from 600 to 1600 mm with the south-eastern districts receiving heavy rainfall (2,150 mm). Annual rainfall in Maharashtra varies from 600 mm to 2,000 mm with the lowest in Marathwada region (882 mm) and the highest in Ghat and coastal areas (2,000 mm and above).

The most important crops grown in the country are rice, wheat, maize, oil seeds, pulses, sugarcane, cotton and vegetables. In MP, major crops are soybean, gram, lentil, wheat, oil seeds, pulses, chillies and cotton where as major crops grown in Maharashtra are sorghum (*jowar*), rice, maize, millet (*bajra*), cotton, sugarcane, oil seeds, pulses, grapes, citrus fruits and vegetables. MP is leader in pulse crops followed by Maharashtra, stands third in total food grains production and second in oil seeds production, while Maharashtra stands third in coarse cereals production and second in cotton and sugarcane production in the country.

1.4.2. Soil resources

Soils of India have been grouped under major soil orders: vertisols (27.96 million ha), aridisols (14.07 million ha), ultisols (8.25 million ha), mollisols (1.32 million ha), alfisols (44.45 million ha), inceptisols (130.37 million ha) and entisols (92.13 million ha). There are problem saline soils with high salt content, alkali soil, acidic soils (6.5 million ha) and peaty and marshy soils (0.27 million ha).

Indian soils contain only 0.05% nitrogen (N), 0.6% of organic carbon, and 1.03% of organic matter on average due to the tropical climate. Red soils are generally deficient in N, phosphate (P), humus and lime with varying depth and fertility and produce a large variety of crops under rain-fed or irrigated conditions. Lateritic soils are deficient in potash (K), P and lime and are important for rice. Black soils are deficient in N, P and organic matter and are suitable for cotton cultivation. Alluvial soils are the most fertile amongst the Indian soils and they support a variety of crops, including rice, wheat and sugarcane (NAAS 2012).

Black soils are mainly found in the Deccan Trap and are distributed over nearly 47.6% of MP in which cotton and soybean are mostly grown. Red yellow soils cover almost 36.5% of the state and are mostly found in Bundelkhand and Baghelkhand regions with rice as a major crop. Alluvial soils and laterite soils are found in the north-western districts, especially in the plains of Bundelkhand and Chambal regions. Loamy soils are found in the plains and river belts. Besides the above, mixed soils are found in many parts of the state on which crops like corn and *bajra* are grown.

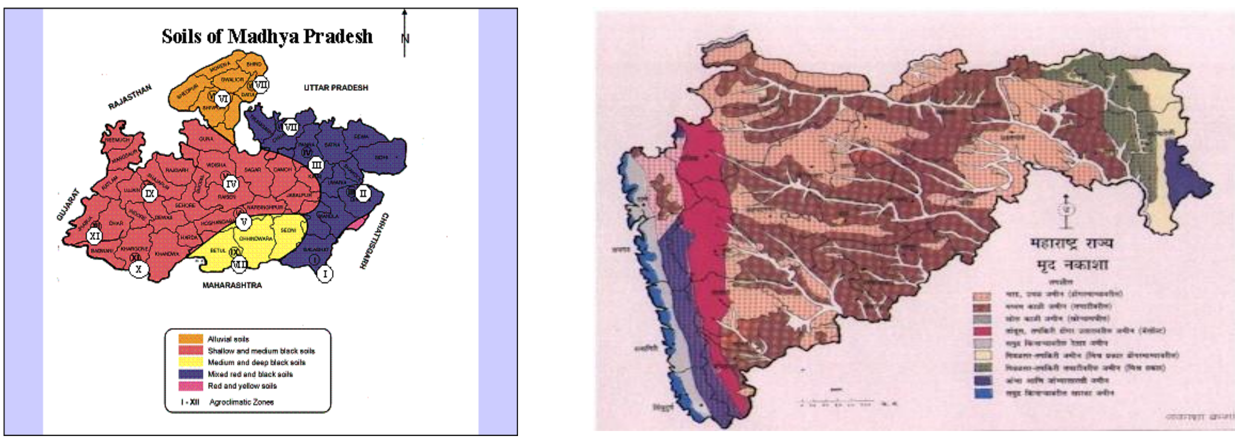


Figure 2. Soils on Madhya Pradesh and Maharashtra

Figure 2. Soils of Madhya Pradesh and Maharashtra.
Source: www.mpenvis.nic.in, www.mahaagri.gov.in

In Maharashtra, black cotton soils, which are best suited for cotton crop cover about 26.3% of the state and are found in Deccan plateau. The Eastern Maharashtra, especially Wainganga basin consists of alluvial soils. Lateritic soils are prevalent in Mahabaleshwar, Bhima Shankar and Matheran. Red soils are distributed in the southern part of Sahyadri. Coastal saline soils are present along the coast and problem soils are present in semi-arid tracts of Sangali, Satara, Solapur and Ahmednagar districts.

CHAPTER II

2.1. Soil degradation

Degraded lands form more than 57% of the total reporting area in India against 17% in the world. There are several natural degrading processes such as desertification, erosion and salinity, accelerated by anthropogenic activities. Annual soil loss is estimated to be about 5.3 billion t through erosion. Soils are adversely affected due to: water and wind erosion (94.87 million ha), water logging (0.91 million ha), soil alkalinity and sodicity (3.71 million ha), soil acidity (17.93 million ha) soil salinity (2.73 million ha) and mining and industrial waste (0.26 million ha) as per *Handbook of Agriculture* (ICAR 2010). About 8.71% of the geographical area was used for non-agricultural purposes in 2010–2011 and this area is estimated to be increasing at the rate of 0.3 million ha per year as population expands and urbanization spreads.

Soil pollution due to air and water pollutants arising out of burning of fossil fuels and industrial emissions and urban and industrial waste water and water polluted by agrochemicals such as fertilizers and pesticides is causing chemical contamination. Excessive use of heavy machinery for cultivation and harvesting in rice-wheat cropping systems and intensive cultivation in conjunction with low organic inputs are responsible for loss of soil structure and consequent compaction. Inappropriate soil management such as tilling along the slope and lack of crop cover during heavy rainfall is responsible for accelerated soil erosion with consequent loss of land productivity. Soil biodiversity is being destroyed due to the soil biota-habitat destruction and management practices that reduce soil organic matter.

2.2. Integration of soils into policy and implementation in agriculture sector

Agricultural land is viewed primarily as a medium of plant growth and most soil management technologies have evolved with the objective of increasing and sustaining high agricultural productivity. However, GOI identified soil degradation as a grave problem in the context of achieving food security and included soil conservation and soil health programmes in long-term planning. Soil fertility research was strengthened in the 1960s with the introduction of high yielding varieties. Research and education were combined during this period through coordinated agronomic research for soil management, development of agricultural university system by strengthening of ICAR trials and the Indian Agriculture Research Institute (IARI). Central Soil Salinity Research Institute

(CSSRI), Karnal was established to examine saline soil related issues. In 1970s, emphasis was placed on nutrient balance and soil fertilizer management in multiple cropping systems. Central Research Institute for Dryland Agriculture (CRIDA) was established at Hyderabad in 1970 while the Potash Research Institute of India was established at Gurgaon in 1977. The fertilizer manufacturing industry also expanded, with the Fertilizer Association of India playing a key role. An exclusive department was formed to examine fertilizer manufacturing, imports, subsidies and quality control related issues.

Meanwhile, micronutrient research received greater attention in the 1980s once zinc deficiency was detected in intensive cropping systems. During this period, an international symposium was organized on “soil fertility evaluation” which was a landmark in soil fertility research and management in India; this led to an inventory of soil resources and coordinated research projects on correlation of soil tests with crop response, research on micronutrients and biological nitrogen fixation as well as long-term fertilizer experiments. This paved the way for establishing the Indian Institute of Soil Science (IISS) in 1988 to focus on research, evaluation and management of soils. Further, with the increasing concerns about food quality, groundwater quality, soil biodiversity etc., there appears to be a reorientation and integration of different soil management technologies. Thus, soil fertility and degradation became major considerations in national and state policy documents.

National policy for farmers (2007) stated soil health management as one of its major goals to improve farm productivity by emphasising organic farming and integrated nutrient management. The current national agriculture policy: *Vision 2020* mentions sustainable agriculture, promoting organic manures and bio-fertilizers to optimize efficiency of nutrient base and precision farming. Integrated nutrient management (INM) occupies a prime place in the policy which includes; enhancing soil testing services, improving supply and distribution of fertilizers, balanced and optimum use of fertilizers, correcting distortion in relative prices of primary fertilizers and location specific research on efficient fertilizer practices.

2.2.1. Government administrative machinery at national level

Certain departments and divisions within relevant ministries have been established by GOI to focus on SHM, to formulate programmes and schemes, and to develop strategies and monitoring mechanisms.

Table 2. Key Ministries and Departments at National Level

Organization	Department	Divisions	Programs/activities
Ministry of Agriculture	Department of Agriculture Cooperation (DAC)	INM (Integrated nutrient management)	Soil fertility maps, organic Package of Practices, National Mission on Sustainable Agriculture, National Programme on Monitoring Soil Health and Fertility, Soil Health Card Programme, promoting use of INM, strengthening of fertilizer quality control labs and National Programme on Organic Farming.
		Extension	Supporting extension programmes through Directorate of Extension Education and Mass media
		Divisions; NRM, Rain-fed Farming System and RKVY (*Rashtriya Krishi Vikas Yojana*)	Soil conservation works, training and extension activities
	Department of Agriculture Research and Education (DARE)	Agricultural Education	ICAR (Indian Council of Agriculture Research) system (research institutes and universities)
		Agricultural Extension	Farm Knowledge centres/ Krishi Vigyan Kendras (KVKs), Agriculture Technology Information Centres (ATICs) for research extension
Ministry of Chemicals and Fertilizers	Department of Fertilizers		Fertilizer manufacturing, imports, regulation, quality control and subsidy policy
Ministry of Rural Development	Department of Land Resources		IWMP (Integrated Watershed Management Programme)

Source: Relevant ministries

2.2.2. Soil health management (SHM) programmes

Information on soil fertility status is needed for enhancing crop productivity through balanced nutrient management, promoting judicious use of costly external inputs of nutrients and enhancing the efficiency of scarce water resources (Sahrawat 2006). Even in water-limiting environments there is potential to enhance agricultural productivity through efficient management of soil, water and nutrients in an integrated manner (Twomlow et al. 2008). On realizing the importance of SHM, the government formulated and implemented the following programmes:

National Project on Organic Farming (NPOF) was started during 2004–2005 under the supervision of the National Centre of Organic Farming (NCOF) with the mandate to provide training to stakeholders on organic farming, conduct statutory quality analysis of bio-fertilizers and organic fertilizers under Fertilizer Control Order (FCO), 1985 and extend support for organic input production units under capital investment back-ended subsidy scheme in collaboration with the National Bank for Agriculture and Rural Development (NABARD).

Rashtriya krishi Vikas Yojana **(RKVY)** launched in 2008 provides funds for establishment of fertilizer testing labs and soil testing laboratories, preparation of soil fertility maps and a soil fertility index, and the establishment of fertilizer testing labs.

National project on management of soil health and fertility (NPMSHF) was started during 2008–2009 for facilitating and promoting INM through judicious use of chemical fertilizers, including secondary and micronutrients, in conjunction with organic manures and bio-fertilizers for improving soil health and its productivity. The focus areas included: strengthening soil-testing facilities to provide soil test-based recommendations to farmers, ensuring effective implementation of (FCO 1985) and upgrading the skill and knowledge of soil testing lab (STL) staff, extension staff and farmers.

National Mission on Sustainable Agriculture (NMSA) was launched during 2014–2015 with the aim of making agriculture more productive, sustainable and climate resilient. SHM was an important intervention through strengthening of existing STLs for micronutrient analysis, setting up new STLs and mobile soil testing laboratories (MSTLs), capacity building at various levels, establishment of fertilizer testing facilities, creation of a data bank for site-specific balanced use of fertilizers, preparation of digital district soil maps and the development of soil fertility monitoring system.

A Soil Health Card (SHC) scheme was launched during 2015–2016 for issuing soil health cards (SHCs) once in 3 years at the rate of one sample in 10 ha for rain-fed land and 2.5 ha for irrigated land. SHC consists of details of major nutrients, secondary nutrients, micronutrients and physical parameters along with advice on corrective measures. Government has planned to issue SHCs to all farmers in 15 states in 100 districts that consume 50% of total fertilizers in the country. Besides the above, programmes such as Dryland Agriculture Mission, National Food Security Mission (NFSM), National Horticulture Mission (NHM) and crop specific programmes also addressed soil health issues as part of integrated crop management.

2.2.3. Research, education and extension on soil health management

Research and education on soil issues is the responsibility of the Indian Council of Agriculture Research (ICAR) with its 108 research institutes working on various themes and 42 state agricultural universities (SAUs), one central university (Manipur) and one university – Indian Agricultural Research Institute (IARI) spread across the country. Specifically NRM (natural research management) institutes of ICAR focus on soil and water related issues. Research extension takes place through ATICs (Agricultural Technology Information Centres) which are established in ICAR institutions and SAUs to provide greater coordination and intensive interaction between the researchers and technology users in contributing towards the dissemination of information.

Agriculture Technology Management Agency (ATMA) programme was launched during 2005–2006 under 'Support to State Extension Programs for Extension Reforms' scheme to provide dedicated manpower support at state, district and block levels and strengthening of the training component. Release of funds under ATMA scheme is based on the state extension work plans prepared by the state governments based on number of farm households and administrative blocks. At present, 640 ATMAs are functioning (one in each district) in the country.

2.2.4. Watershed Development Programme (WDP)

Watershed programmes address soil degradation issues: they conduct soil moisture conservation works and capacity building of rural communities. National Watershed Development Programme in Rain-fed Areas (NWDPRA) of Union Agriculture Ministry and NABARD-funded WDP implemented watershed activities on a large scale. Integrated Watershed Management Programme (IWMP) implemented by the Department of Land Resources (DOLR), Ministry of Rural Development was launched during 2009–2010 as a follow-up of Drought Prone Areas Programme, Desert Development Programme and Integrated Wastelands Development Programme. Production systems, institution and capacity building and NRM components of IWMP are important from soil conservation and fertility management point of view.

2.3. Investment

Under soil specific programmes, total investment goes toward SHM. However, under other programmes, roughly 5 to 10% might directly go toward SHM-related activities and related training component. In the case of watershed programmes, roughly 20% of the funds go toward soil moisture conservation works and the rest goes towards water harvesting works, plantation activities etc. All major SHM schemes are fully funded by GOI. Hence, GOI initiatives are very important to gear up state machinery toward SHM. In case of WDP, the centre state investment ratio varies from

75:10 (pre-IWMP) to 90:10 (IWMP). The actual investments do not generally match the allocation, with the average expenditure being in the range of 60 to 70% of allocation at the country level. The absorption capacity of the states varies depending on the existing socio-economic-political situation and administrative arrangements in respective states. Besides the above, there could be gap between national policy and state requirement as India is a country of varied geography, climate and socio-economic factors.

Table 3. A Broad Estimate of Investment in Key Programmes

Program	Investment
National Project on Organic Farming (NPOF)	INR 560 million spent since 2007–2008, INR 170 million for 2015–2016
***Rashtriya krishi Vikas Yojana* (RKVY)**	INR 300.55 billion expenditure so far under RKVY and 2015–2016 allocation is INR 45 billion
National Project on Management of Soil health and Fertility (NPMSHF)	Project outlay of INR 4.3 billion – now merged with NMSA.
National Mission on Sustainable Agriculture (NMSA)	INR 9.85 billion for 2015–2016
Soil Health Card (SHC) scheme	INR 5.68 billion outlay to test 140 million soil samples in 3 years, 2015–2016 allocation is INR 1 billion to provide soil health cards and INR 560 million to set up 100 mobile STLs.
NWDPRA (National Watershed Development Programme in Rain-fed Areas)	INR 33.35 billion was released up to 2013–2014 to treat 10.58 million ha, brought under umbrella of IWMP.
Pre IWMP watershed programmes	INR 119.82 billion spent (1995-1996 to 2013–2014) to treat 32.31 million ha
Integrated Watershed Management Programme (IWMP)	About INR 100 billion was released from 2008-2009 till 2014–2015 to treat 34.264 million ha, INR 15 allocated during 2015–2016.
National Food Security Mission (NFSM)	INR 13 billion total allocation for 2015–2016, About INR 5.6 billion spent on INM component since inception.
Subsidy allocation in fertilizer sector	INR 729.68 billion projected for 2015–2016

Department of Agricultural Research and Education (DARE)	Expenditure of INR 355 billion (from 2007-2015), About INR 36.91 billion is allocated for 2015–16
Agricultural Technology Management Agency (ATMA)	About INR 27 billion expenditure since inception till 2014–2015. INR 6.55 billion allocated for 2015–2016.

Source: *Pocket Book of Agriculture Statistics 2014*, relevant ministries' websites.

2.4. SHM implementation in states (with examples of MP and Maharashtra)

2.4.1. The organization structure of agriculture department varies across the states in terms of positioning and nomenclature of the staff along with administrative arrangements. In MP, Department of the Farmer Welfare and Agriculture Development is the key government agency implementing agriculture related schemes of the Union Ministry of Agriculture and the state government. One senior level official handles the soil related programmes at state level but the subject forms an integrated part of the departmental activities in general. Directorate of Rajiv Gandhi Mission for Watershed Management (RGMWM) of Department of Panchayat and Rural Development has the mandate to implement IWMP by deploying multidisciplinary teams, project implementation agencies and watershed development team members at project level. These two key departments mostly work in parallel to each other. In Maharashtra, implementation of the agriculture schemes is supervised technically and administratively by respective Directorates of Soil Conservation, Horticulture, Extension and Training, Inputs and Quality Control at state level under the control of the Commissioner of Agriculture who is also Chief Executive Officer for VWDA (Vasundhara Watershed Development Agency) and there appears to be a better integration of staff of Soil Conservation Directorate and VWDA at different levels in watershed villages. At watershed village level, agriculture assistant undertakes soil conservation work and extension activities while watershed development team member takes up water harvesting and soil moisture conservation work.

2.4.2. Process of implementation

Each state prepares state and district annual agriculture action plans according to the mandate and procedures given in GOI schemes. States have flexibility to identify the focus areas on priority basis within the ambit of national schemes. There are state initiatives for which budget comes from state plan schemes. In MP, a scheme for advance storage of fertilizers was launched during 2014–2015, with a view to ensure timely supply of fertilizers to farmers by making a provision to reimburse certain expenditure incurred on loans taken by cooperative societies towards improving storage facilities. State-funded projects on soil conservation and water harvesting such as farm ponds and cement check dams are mostly implemented through the Soil Conservation Directorate of Agriculture Department in Maharashtra. State initiatives include: distribution of zinc sulphate and ferrous sulphate with 50% subsidy in 175 Zn deficient blocks and 106 Fe deficient blocks in Maharashtra. The number of watershed projects sanctioned is much higher in Maharashtra than in MP since Maharashtra has been a leader in watershed activity for several decades and the state has large chunks of its area classed as arid and semi-arid. MP's organic farming policy pays special attention to the tribal areas where organic farming has been in practice naturally; Maharashtra's organic farming policy has a target of increasing 10,000 ha of organic farming per year by encouraging intercropping of pulses in all major cereal crops and assessing district fertilizer demand on the basis of fertility status. MP has adopted a concept called bio farming through bio-villages for the promotion of organic farming. Bio-farming is implemented in 1,565 villages selected from 313 blocks of 48 districts. Major crops grown under organic farming are: soybean, wheat, lentil, maize, pigeon pea, vegetables and sugarcane. Mostly large and medium farmers are involved in organic farming compared to small farmers although in tribal areas, farmers practice natural organic farming as a norm.

2.4.3. Investment

Most of the investment in SHM comes from GOI-funded schemes. However, the absorption capacity depends on efficiency of planning and implementation of the respective states. Maharashtra's absorption capacity appears to be higher than that of MP due to better staff strength and infrastructure of agriculture department.

Table 4. Investment in Major Agriculture and WDP programmes in MP and Maharashtra

Program / Scheme	Madhya Pradesh	Maharashtra	Remarks
RKVY (2015–16)	INR 2.17 billion (INR 26.83 billion expenditure up to 2014–2015)	INR 3.36 billion (INR 51.29 billion expenditure up to 2014–2015)	100% GOI funding. Maharashtra has double the expenditure of MP up to now.
NMSA (2015–2016)	INR 165 million	INR 604 million	INM component is less than two% in MP and less than 1% in Maharashtra. 75:25 ratio

			(centre : state)
IWMP	INR 34.36 billion outlay for 504 projects in 5447 villages. INR 9.5 billion expenditure so far.	INR 63.00 billion outlay for 1170 projects in 10630 villages, INR 17.12 billion expenditure so far.	No funds were released during 2014–2015 from DOLR due to fund constraints. 90:10 ratio (centre : state)
NFSM (2015–16)	INR 3.04 billion	INR 2.19 billion	More wheat, pulse and rice districts identified in MP, hence more allocation. 50:50 ratio (centre : state)
SHM (2015–16)	INR 88.65 million	INR 72 million	100% GOI funding
ATMA (2015–16)	INR 700 million	INR 730 million	50:50 ratio (centre : state)
State funds (2014–15)	INR 36.47 billion	INR 44.40 billion	Toward establishment costs and additional state level activities

Source: State agriculture departments, RGMWM and VWDA.

2.5. Institutional credit

The available data shows that INR 7,116.21 billion of institutional credit was accessed (INR 5,730.01 billion short-term loans and INR 1,386.20 billion medium- and long-term loans) in the country during 2013–2014 in agriculture sector. Under Interest Subvention Scheme, 2% of interest is borne by the GOI on the loans extended by the commercial banks on their own funds used for short-term loans up to INR 0.3 million per farmer provided the lending institutions make the short-term credit available at the rate of 7% to the farmers. In MP, farm loans are available at 0% interest at present due to government intervention. Both the public sector and private sector banks are offering soil development and land development loans. One such product extends loans up to INR 0.50 million toward land levelling, soil reclamation and any other soil conservation measures as per the estimation of concerned department of state government to the farmers. A total of 120 million kisan (farmer) credit cards (7.46 million in MP and 9.1 million in Maharashtra) with validity of 5 years along with insurance coverage were issued from 1998–1999 to March 2013–2014. But there is no specific data available on how much credit might have gone toward SHM.

2.6. Extension and training

Public extension in agriculture formed a part of national policy and has evolved over a period of time. The training and visit system introduced in the mid-1970s focused on giving quality training and exposure inputs (with a focus on food grains) to agriculture extension officers (AEOs) and increasing the coordination among farmers, subject matter specialists and extension workers. However, extension goes beyond helping the farmers to solve their problems in India. More has to be invested in human resource development of the clients, teaching the farmers the management and decision-making skills, leadership and organizational skills (Swanson and Clarr 1984).

State extension officials undergo different types of training programmes categorized as national, skill development, refresher, foundation and special technical training programmes. Senior officials undergo national level training courses and middle to village level officials take part in the rest of the training courses. State-level training and extension institutes (SAMETIs) provide training to AEOs as per the training calendars prepared by them. Extension education institutes working under Directorate of Extension, DAC and national-level training and research institutes provide training to AEOs, but in smaller numbers. Certain training courses are organized exclusively on SHM and general training courses usually include one or two sessions on SHM. They curriculum includes sustainable soil management in specific training programmes on SHM, organic farming and sustainable agriculture and general training courses including a few sessions on the subject. However, the formal training inputs received on SHM do not appear to be sufficient since it is difficult for the available training infrastructure to cater to the needs of the staff. The regular target-driven review meetings in the agriculture department on SHM are the key providers of information to the extension officials but technical orientation courses are in severe shortage. Watershed programmes have huge funding but usually training is confined to watershed functionaries only.

2.7. Special government initiatives to address SHM

2.7.1. Soil testing as a priority

The soil testing programme was started in India during 1955–1956 with the establishment of 16 soil testing laboratories (STLs) under the Indo-US operational agreement for determination of soil fertility and fertilizer use. In 1965, the existing laboratories were strengthened and nine new laboratories were established to serve the intensive agricultural district programme in selected districts. Further, 25 new STLs and 34 mobile STLs were added in 1970. Assessment of nutrient deficiency indices and delineation of micronutrient deficient areas started in 1980s through coordinated research projects. Annual installed analysing capacity of STLs had grown at a rate of 11% during the last two decades. Further, the soil heath card programme has given a much-needed boost to soil testing activities. Gujarat issued SHCs to 1.27 million farmers and 0.55 million cards are going to be issued under the E gram project. Farmers' festivals were celebrated to give thrust to the programme in Gujarat and Uttar Pradesh states. Andhra Pradesh initiated public–private partnership arrangements to meet the targets. Tamilnadu leads the states with 354 STLs and Tripura has just one STL. Three states (Meghalaya, Arunachal Pradesh and Sikkim) did not report a single STL in the farmers' portal. In MP, it is proposed to establish 265 more STLs (75 departmental STLs with RKVY fund and 190 marketing centres with ATMA funds) with INR 945 million investment; Maharashtra also has similar plans. However, it would take

4,700 labs at the rate of 10,000 per annum distributed across the country to test the required number of samples.

Table 5. Soil Testing Infrastructure and Progress in Soil Health Cards

	Particulars	India			Madhya Pradesh			Maharashtra		
		Static	Mobile	Total	Static	Mobile	Total	Static	Mobile	Total
1	No. of soil testing labs (STLs)	1325	105	1 530	75	3	78	142	68	210
2	Approximate annual installed capacity of STLs	10.31 million			0.50 million			1.03 million		
3	Annual analysing capacity of STLs per 1000 ha gross cultivated area	51 samples			23 samples			43 samples		
4	Soil testing charges	Varies in different states for STLs operated by different government agencies			General sample: INR 5/INR, INR 3/for scheduled caste (SC) and scheduled tribes (ST), micronutrient/special sample: INR 40 and INR 30/ for SC and ST) for state Agriculture Dept operated STLs			INR 35/ per or INR 15/general sample, INR 200/ per micronutrient /special sample for state Agriculture Dept operated STLs		

5	Total soil health cards issued in million up to August 2014	48 million	1.68 million	3.34 million

Ref: Farmers portal, Department of Farmer Welfare and Agriculture Development, Madhya Pradesh, Department of Agriculture, Maharashtra

District STL capacity variation is very high within the states. For example, Nanded district with five STLs can test 29,000 samples per annum whereas Pune district with 20 STLs can test 147,500 samples and Gondiya district has just one STL in Maharashtra. As seen in MP, each STL's annual testing capacity varies from 100 per lab (KVK, Hoshangabad) to 20,000 per lab (Dhar STL, Damoh district). In Maharashtra, there are 64 MSTLs operated by government, PSUs, KVKs etc. and four by private agencies. The capacity of MSTLs is very low compared to stationary STLs. Capacity utilization appears to be poor (about 50%) in most of the states other than Odisha. As per available information in July 2015 in farmers' portal, about 5,352 staff (including 1,969 support staff) are working in 1,530 STLs. In fact, some labs did not report any employees, hence leading to doubt regarding the functioning of these labs. Some of the constraints in establishing and utilizing STLs are: shortage of required technical personnel, non-updating of technical knowledge of staff and lack of space for establishing STLs in the case of government organizations.

Most of the private STLs are established by fertilizer companies, agri-biotech companies, sugar factories and growers' associations (of grapes, pomegranates etc.). However, the analysing capacity is limited for private STLs. There are 68 private STLs (64 static and 4 mobile) in Maharashtra as reported in the farmers' portal. Out of them, 30 STLs are operated by sugar factories, two by RCFL (Rashtriya Chemical Fertilizers Ltd.) and four by educational institutions. MP has about 20 private STLs but this was not reported by the Agriculture Department in the farmers' portal. The STL equipment of the private labs appears to be better than others but there is not much difference in technical knowledge of the staff.

Usually, same soil testing charges are fixed for STLs operated by respective state agriculture departments but they differ vastly from state to state. In the case of STLs operated by other government agencies and private agencies, soil testing charges vary widely. The highest cost charged for basic analysis is INR 150 by an agro bio-tech company and INR 1,050 for advanced analysis (including micronutrients, sulphur and boron) by KVK, Dhule in Maharashtra.

2.7.2. Fertilizer subsidy

The fertilizer subsidy is budgeted at INR 729.7 billion in 2015–16. There are also pending bills of INR 300–350 billion that need to be cleared on account of this subsidy. Together, it amounts to more than INR 1,000 billion, which is more than 10% of the centre's tax revenue, putting a substantial pressure on the State exchequer (Ashok Gulati, 2014). Urea is the only fertilizer where pricing and distribution is controlled statutorily by the government. Unduly low prices of urea, at INR 5,360 per tonne account for nearly two-thirds of this subsidy and Government of India announced that this cost would not be enhanced for the next 4 years. Nutrient-based subsidy (NBS) is extended for decontrolled phosphate (P) and potassium (K) fertilizers with effect from April 2010 with a view to promote balanced fertilization. The latest circular on NBS indicates a fixing subsidy of INR 20.875, INR 18.679, INR 15.500 and INR 1.677 per kg of N, P, K and S respectively (MOCF 2014). At present, 22 grades of P and K fertilizers and 16 grades of complex (NPK) fertilizers are covered under NBS policy. The government provides assistance on fertilizers fortified with zinc and boron under the NBS scheme. Concession on urea, decontrolled P and K fertilizers including imported di-ammonium phosphate (DAP) and muriate of potash (MOP) is payable only on the quantities sold for agricultural purposes; hence states are given the responsibility of certifying the sales. No subsidy is available on fertilizer mixtures (Annex 1).

2.7.3. Fertilizer quality control (FQC)

In order to check the quality of the fertilizers sold in the country, 78 fertilizer quality testing control laboratories (FQTLs) have been established with an annual analytical capacity of testing 152,470 samples. FQC system provides information on the quality of imported fertilizers at ports and checks the quality of indigenously manufactured fertilizers. There are four FQTLs located at Jabalpur, Indore, Gwalior and Bhopal, with an analysing capacity of 16,000 per annum in MP, while 5 FQTLs are located at Pune, Nashik, Aurangabad, Amaravati and Kolhapur in Maharashtra with analysing capacity of 18,000 per annum. They test samples of chemical and bio-fertilizers and heavy metals as per the norms of National Accreditation Board for Testing and Calibration Laboratories (NABL). The samples are analysed and results are dispatched to concerned fertilizer inspectors usually within a month. At present, 26 straight fertilizers (13 N, 8 P, 5 K and 2 sulphur), 19 NPK complex fertilizers and 16 NP complex fertilizers, 29 customized fertilizers, 14 fortified fertilizers, 17 water soluble fertilizers and 16 micronutrient fertilizers are notified under FCO, 1985. Phosphogypsum, a by-product of the fertilizer industry containing 16% S and 21% Ca is incorporated in FCO, 1985. To encourage use of bio-fertilizers, Rhizobium, Azotobacter, Azospirillum, phosphate solubilizing bacteria (PSB), potash mobilizing bacteria (KMB), zinc solubilizing bacteria (ZnSB), Mycorrhizae, Acetobacter and a consortia of bio-fertilizers are incorporated in FCO, 1985. Generalized specifications of organic manures, vermillion compost and phosphate rich organic manure are also included.

2.7.4. Integrated nutrient management (INM) and balanced fertilization

Government is promoting integrated nutrient management (INM), advocating soil test-based balanced and judicious use of chemical fertilizers in conjunction with use of fertilizers fortified with micronutrients, organic sources and bio-fertilizers for improving soil fertility, especially soil carbon for achieving better fertilizer use deficiency (FUE). Encouragement is given for establishing vermillion compost units and biogas slurry units under different schemes. Up to INR 500 per ha is provided under NFSM, NPMSHF and oilseed production programme and up to INR 1,000 per ha under centrally sponsored sugarcane development scheme towards the supply of gypsum, lime and micronutrients.

2.7.5. Incentives for organic farming

There is a provision of 25% of total financial outlay subject to the maximum of INR 4 million per unit, whichever is less for establishing bio-fertilizers-bio-pesticides unit and 33% of total financial outlay subject to the maximum of INR 6 million per unit, whichever is less for establishing fruit and vegetable market waste compost unit under the Capital Input Subsidy Scheme and National Project on Organic Farming. Work Plan Organic Farming Scheme provides INR 50,000 per project in the case of group farming. National Horticulture Mission provides INR 10,000 per ha for adoption of organic farming. Farmers can avail of 50% cost of cultivation or INR 100 per ha (whichever is less) towards the supply of Rhizobium and PSB under the Work Plan Organic Farming scheme. This scheme also provides support of INR 2,500 per unit toward establishing a vermillion compost unit and INR 15,000 per unit for supply of a neem grinder for the preparation of neemark. There are about 0.72 million ha, 0.23 million ha and 0.08 million ha under certified organic farming in India, MP and Maharashtra respectively. In MP, organic farming policy focuses on tribal farmers who practice organic farming naturally, by including them in organic certification scheme where a 50% subsidy is extended on a certification fee to the farmers.

2.7.6. Loans for establishing STL

To establish additional STLs under public–private partnership mode, there is a general provision of 50% of project cost limited to maximum of INR 3 million as a one-time subsidy and in the case of mobile STLs, it is 75% of project cost limited to INR 3 million as a one-time subsidy under NPMSHF. It takes at least INR 7.5 million to establish a fully equipped STL and now some agencies and individuals are coming forward to establish STLs by availing of bank loans. National Bank for Agriculture and Rural Development (NABARD) refinances commercial banks toward bank loans extended to the tune of INR 1.08 million for establishing STL and a soil health counselling facility. Some banks such as Bank of Maharashtra (Bhigwan) promoted STL in collaboration with RCFL, a fertilizer company. However, consolidated details are not available on this.

2.8. Civil society organization (CSO) initiatives

CSOs are an important source of support for farmers in India, mostly by forming self-help groups or farmer-based organizations. Professional Assistance for Development Action (PRADAN) focuses on productivity enhancement with a focus on land and water development; they have an association with the Government of MP to implement various activities under RKVY and ATMA. The Bharatia Agro-Industries Foundation (BAIF) is working in the agricultural sector in 12 states with a focus on soil and water conservation works on degraded lands, composting and agroforestry. BAIF facilitated formation of farmers' cooperatives and federations of self-help groups, which formed the Vasundhara Agri-horti Producers Company Ltd. for imparting knowledge on package of practices including soil fertility management for raising crops. Watershed Development Trust (WOTR) also works in watershed sector and few of their projects have SHM focus. In Maharashtra, CSOs like AFARM (Action for Agriculture renewal in Maharashtra), Agriculture Development Front, NARI (Nimbkar Agricultural Research Institute), appropriate rural technology institute (ARTI) works in association with KVKs, and links between research and training centres and farmers. LEISA India (Low External Input and Sustainable Agriculture India) organizes short-duration learning workshops and long-duration customized programmes on sustainable farming. The Centre for Sustainable Agriculture (CSA) advocates sustainable practices as well. Some watershed projects are implemented by CSOs as project implementing agencies and in some other cases they act as resource agencies. The RKVY programme encourages CSO participation in arranging demos, establishing farmer field schools and facilitating training activities in association with the agriculture department. The CSOs' reach of farmers is modest but where they have a reach, high quality knowledge inputs are given to farmers. The general observations on government system by CSOs are: collection of wrong soil samples, improper timing of soil sample collection, not communicating the results on time and not supplying the fertilizers on time.

2.9. Access to chemical fertilizers

2.9.1. Production and imports

Consumption of N, P and K chemical fertilizers has increased since 1966–1967 and at present, the demand is expected to grow annually by 5 to 7% since they are the immediate source of nutrients in soils. The all-India average consumption of fertilizers has increased from 105.5 kg per ha in 2005–2006 to 144 kg per ha in 2011–2012. Theemand for chemical fertilizers (in thousands of tonnes) is projected to be 33,754, 12,764, 6,476 and 4,934 for urea, DAP, single super phosphate (SSP) and MOP respectively for direct consumption in 2017–2018 as per the *Working Group Report on Fertilizer Industry for Twelfth Five-Year Plan*. A policy has been adopted by GOI which involves mix of three options, i.e. domestic production based on indigenous/imported rock phosphate, imported sulphur and ammonia; domestic production based on indigenous/imported intermediates, i.e. ammonia and phosphoric acid; and third, import of finished fertilizers. India imports 25% of urea, 90% of DAP and 100% of MOP. The installed capacity has reached 13.26 million t for N and 7.06 million t for P in the year 2014–15, making India the third largest fertilizer producer in the world. The rapid build-up of fertilizer production capacity in the country has been achieved as a result of a favourable policy environment facilitating large investments in the public (10 public sector units), co-operative and private sectors.

There are 30 large urea plants, 21 units manufacturing DAP and complex fertilizers and 2 units manufacturing ammonium sulphate as a by-product. There are also 97 medium and small-scale units in operation producing SSP. Under the new pricing regime for urea units, economically efficient units are being permitted to produce beyond their re-assessed capacity to substitute or minimize imports. The government notified the new investment policy in 2012 followed by an amendment in 2014 to facilitate fresh investment in the urea sector to make India self-sufficient. Manufacturers are allowed to sell at a price up to 5% higher than the maximum retail price of the subsidized coated (e.g. neem or sulphur coated urea) and fortified fertilizers and 10% higher for zincated urea and boronated SSP. There are 153 micronutrient manufacturing units and 16 units manufacturing a 100% water soluble solid NPK mixture at present. Most popular fertilizers are urea, DAP, SSP, MOP followed by complex fertilizers in the case of major nutrients and it is ferrous sulphate, zinc sulphate and manganese sulphate in the case of micronutrients and this trend is almost similar in all the states.

Table 6. Production, Imports and Consumption of Chemical Fertilizers in Million Tonnes

Year	Urea		DAP		MOP		Complex fertilizers	
	Production	Imports	Production	Imports	Production	Imports	Production	Imports
2012–13	22.57	8.04	3.65	5.70	---	2.50	6.18	---
2013–14	30.6	7.09	7.36	3.26	---	1.33	7.26	2.91
2014–15	22.58	8.75	3.44	3.39	---	2.08	7.83	2.91

Source: Department of Agriculture Cooperation and Department of Fertilizers

Customized fertilizers, which are soil specific, crop specific and area specific and formulated on the basis of soil testing and agronomic multi-location trials, are being produced on a small scale.

2.9.2. Distribution

Fertilizer shortages in the early 1970s led the government to pass the Fertilizer (Movement Control) Order, 1973, which brought the distribution of fertilizers under government control. State

Cooperative Marketing Federation Ltd (MARKFED), District cooperative societies, village level cooperative societies and private agencies are part of the network. State agro-industries corporations and state commodity federations also take part in this in some places. The ratio of participation of cooperatives and private agencies is around 30:70 and the distribution network, consisting of wholesalers and retailers, has about 261,824 dealers. Approximately 75% of fertilizer is transported by rail and 25% by road. Production is continuous while consumption is seasonal with two distinct agricultural seasons (*kharif* from April to September and *rabi* from October to September), so storage is very important. Food Corporation of India and Co-operatives have established warehouses to store about 38 million t (for all goods) while the rest is taken care of by private agencies. In MP, to ensure timely supply of fertilizers, government has proposed to reimburse the interest on the loans taken for advance storage of the fertilizers through construction of new warehouses by MARKFED and cooperative societies. Some fertilizer companies such as Indian Farmers Fertilizer Co-operative Limited (IFFCO) offer insurance coverage for the fertilizer purchased.

2.9.3. Access to bio-fertilizers

Rhizobium group, Azotobacter group and Azospirillum group strains, PSB/PSM (phosporus soluble bacteria), Zinc solubilizing bacteria and K mobilizing bacteria are the main ingredients of commercially available bio-fertilizers. GOI notified six bio-fertilizers under FCO 1985. Bio-fertilizer production was 65,528 t during 2013–14. Generally, southern states produce maximum quantity of bio-fertilizers with the least production happening in north-eastern states. Approximately 25% of total bio-fertilizer production in the country took place in Tamilnadu while MP and Maharashtra produced 1,408 t and 5,898 t respectively in 2012–2013 according to the National Centre for Organic Farming (NCOF) which works on bio-fertilizer related aspects, quality control, standards formulation, training and extension, developing culture banks and production and distribution of bio-fertilizers.

2.10. Conservation agriculture and sustainable agriculture

Conservation agriculture technologies involve minimum soil disturbance, permanent soil cover through crop residues or cover crops and crop rotation for achieving higher productivity. In recent years, adoption of zero tillage and CA has expanded to cover about 1.5 million ha, mostly as zero-till wheat in the rice-wheat system of the indo-gangetic plains and zero-till maize in some states. Under sustainable agriculture, management practices such as split application, placement of fertilizers at crop root, use of slow release N fertilizers and nitrification inhibitors, mixed/intercropping of pulses, agroforestry measures and non-pesticide management can enhance soil health. Generalized specifications of organic fertilizers (city compost, vermin compost, phosphate-rich organic matter) and composition of castor de-oiled cake are brought under FCO, 1985. However, adoption of these practices depends on the efficiency of the extension system and awareness building among the farmers.

2.11. Access to soil management options

The sources of information accessed by farmers in India are varied. The latest National Situation Assessment Survey of 35,000 agricultural households across India reveals that over 59% of the households received no assistance from either government or private extension services. Of the 41% households which received extension assistance, only 11% of services came from the physical government machinery of the government extension agents, Krishi Vigyan Kendras (KVKs)/farm science centres and state agricultural universities (SAUs). Many farmers depended on other farmers (20%) and mass media (19.6%) and 7.4% depended on private commercial agents (NSSO 2014). Public extension plays an important role in providing soil health information since the progressive/contact farmers or mass media also receive soil health information from the research and public extension system. In fact, farmer friends/contact farmers are encouraged to gain agricultural knowledge as part of the public extension strategy.

2.11.1. Public extension

Sources such as functionaries of agriculture department, KVKs, SAUs, research and training institutes of the ICAR and state governments form important public extension system. The extension activity of the SAUs and ICAR institutes happens through state-level agricultural entities, but sometimes reaches out to the farmers directly. A call centre facility was provided by ICAR-NRM institutes to receive queries from farmers and give them the required advice. The activities include demonstrations, farmer field schools (FFS), farmer–scientist meetings, village fairs, farmers' training courses and study tours at district, state and outside the state levels. KVKs conducted 4,189 on-farm trials on 537 technologies during 2014–2015 under different farming systems. The Agriculture Technology Management Agency (ATMA) provides funding for training the farmers. Besides ATMA, Work Plan Organic Farming Scheme provided INR 20,000 per farmer field school (FFS) to train farmers and provided funds to conduct study tours within and outside the state. About 7,250 and 17,652 interactions were held in FFS in MP and Maharashtra respectively during 2014–2015.

2.11.2. Mass media

The **"**Mass Media Support to Agriculture Extension" and "Focused Advertisement Campaign" schemes fund Doordarshan (national television) and All India Radio (AIR) to make the farmers aware of modern technologies and research on agriculture and allied areas. An exclusive kisan TV channel was started in 2015 but it is yet to take off. Community radio stations (CRS) are gaining popularity. MP has eight CRSs and Maharashtra has 15 CRSs. The tribal welfare department of MP started Bhili CRS to cater to a tribal community and several more CRSs are in the pipeline that aim to provide information in various tribal dialects. Soil health information is also covered under the general agriculture theme in the mass media.

2.11.3. Soil information services

There are a number of information services that provide for soil related information. “Farmers’ portal” provides soil fertility maps and fertilizer status in respective states and this portal enables state agriculture departments (up to block level) to upload information, provide services and give advisories to farmers in their own languages. KRISHINET is the farmers’ portal managed by the government of Maharashtra with about INR 78 million investment: it can be used to send mobile messages to farmers on soil and water testing. In Buldhana district of Maharashtra alone, 45,550 farmers are registered with mKisan-farmers portal. Bhoom Software is developed by KVK Kalwade, Satara district. AGRISNET is a dynamic soil testing module operating in MP. Indian Institute of Rice Research is maintaining a state specific rice knowledge management portal to cater to the needs of rice soils. “My Agriculture information bank” is another website which offers information services. Kisan Call Centres (KCCs) operate from 14 locations in the country and arrange interaction of farmers with senior experts on toll-free numbers to facilitate accessibility to KCC services through mobile phones from 6 a.m. to 10 p.m. 365 days a year. MP has KCC at Indore while it is at Mumbai in Maharashtra. Private media (print and electronic) also have programmes for sending information to the farmers. Periodicals on agriculture in Hindi and in vernacular languages also contribute to dissemination of the information.

2.12. Private Service providers

The private sector in the form of progressive farmers, crop science industry, companies, primary cooperative societies and output buyers/processors is important, especially for large farmers and farmers growing cash crops.

2.12.1. Farmers’ associations

Contact intensity is the highest in farmers’ associations. Maharashtra Organic Farmers Federation (MOFF) is a confederation of 120 CSOs and 142,000 farmers which forms organic groups of 20 farmers each, advocates and conducts training activities in nutrient management practices in organic crop cultivation (composting, bio-fertilizers, liquid organic manures etc.). In MP, Organic Farming Association of India is an important player. Grape Growers Association and Pomegranate Growers Association have a good outreach for reaching soil management related information to their members in Maharashtra. These associations are quite strong in Maharashtra compared to Madhya Pradesh.

2.12.2. Commercial companies

The commercial companies follow a variety of models for delivering and financing extension. Commercial companies (seed, fertilizer, micro-irrigation etc.) supply extension to farmers or farmer-based organizations by offering information services and inputs. This may include sending agronomists into farmers' fields and developing partnerships with NGOs, consultants, research institutes or universities, as well as public providers of extension.

The Mahindra Krishi Vihar, a one-stop farm solution centre by the Mahindra and Mahindra Ltd. tractor and utility vehicle company, Hariyali Kisaan Bazaar, run by DCM Shriram Consolidated Ltd., a fertilizer, seed and sugar conglomerate, a one-stop farmer solution shop of Tata Kisan Sansar by Tata Chemicals Ltd, Godrej Agrovet model and Jain micro-irrigation provide knowledge on soil health information as part of a general package. Contract farming in wheat is practiced in Madhya Pradesh by Hindustan Lever Ltd. Rallis and Industrial Credit and Investment Corporation of India (ICICI). PepsiCo, Adani Agrifresh, and FieldFresh Foods Private Ltd. all encourage contract farming with respect to certain crops in certain areas where soil health information is part of the package. Fertilizer companies such as RCFL, IFFCO, Krishak Bharati Cooperative Limited (KRIBHCO) and Coromandal are taking up extension activities in nutrient management and are independently conducting soil-testing activities, although on a small scale. RCFL established six STLs in 1967 and provided three MSTLs for issuing soil reports and health cards. Seed companies also give information on soil nutrition based on the crop requirement as part of their package of practices. However, private information services often don't target the SHM in a holistic way as they focus mostly on crop productivity enhancement.

2.12.3. Independent entrepreneurs/agencies

Progressive and big farmers are willing to pay for delivery of an integrated set of services that give them access to quality inputs, credit procurement services and field-based advice on technology use. Some agri-business entrepreneurs also established STLs for offering services. "India Mart" provides soil-testing services at Mumbai, Thane, Nagpur (Maharashtra) through an e-transaction portal. A prescribed amount can be paid toward the services. Vision Mark Biotech provides services and supplies bio-fertilizers in Maharashtra. However, the general trend is that farmers prefer to pay for a package of services rather than specifically for soil-testing services or soil health information. Also, they prefer to pay for cash crops rather than for food crops.

2.13. Fertilizer mixtures and their availability

Various types of approved fertilizer mixtures are available based on crop, soil and agro-climatic conditions. The mixtures are usually consumed in the same state where they are prepared and they vary from one combination in Odisha to 29 combinations in Tamilnadu (Annex 2 a). In Madhya Pradesh and Maharashtra, six combinations of fertilizer mixtures are approved (Annex 2 b). Maharashtra has more fertilizer mixture companies than MP (Annex 3).

CHAPTER III

Institutional and political obstacles in soil health management

According to the Vision 2030 report prepared by IISS, Bhopal, soil fertility has dropped to a third of what it was in just 35 years, indicating the reduction of the partial productivity of the fertilizers from 15 kg of the food grains per kg of NPK in 1970 to 5 kg of food grains in 2005. Most of the important soil-based production systems are showing a declining trend of total factor productivity and low nutrient use efficiency due to deterioration of soil health (Ganeshamurthy 2014). Fertilizer consumption in India is highly skewed with wide inter-state, inter-district and inter-crop variations. The consumption ranged from 250 kg per ha in Punjab to 2 kg per ha in Arunachal Pradesh while it is 84.7 kg per ha in Madhya Pradesh and 102.7 kg per ha in Maharashtra as assessed in 2012–2013. During 2013–2014, total NPK consumption in India was 244.82 kg per ha. While per hectare consumption is 243.56 kg in Punjab and 266.11 kg in Andhra Pradesh, it is comparatively low in MP (88.36 kg). Inter district variation in consumption is also clearly visible according to the district level information obtained from Maharashtra. While Ahmednagar has consumption figures of 123 N, 13.6 P and 6.3 K kg per ha, Buldana has only 16.5 N, 8.77 P and 4.69 kg per ha and similar situation exists in all the states. The NPK ratio, a measure of balanced use of fertilizer shows wide interstate and inter-district disparity as well. All India NPK Ratio was 8.2:3.2:1 in 2012–13 where as it was 15:10:1 in MP (due to low K consumption) and 3.5:1.9:1 in Maharashtra in the same year.

3.1. Policy issues

3.1.1. Production of fertilizers

Fertilizer production costs are high and the government subsidizes producers in order to make sure fertilizer is available to farmers at low, controlled prices (even so prices have risen and are out of reach of many farmers). Meanwhile, K and P fertilizers have been decontrolled. As a result, domestic investments in the fertilizer industry have lagged behind and imports have surged. Promotion of complex fertilizers increased tremendously which is leading to imbalanced nutrition. There is inadequate availability of straight fertilizers other than N, P, K and Zn.

3.1.2. Subsidies

The fertilizer industry not the farmers, receives the subsidy; this means that farmers can't buy whatever they want. Fertilizer subsidies need to be comprehensively re-examined to improve balanced nutrition and to target the subsidy more to the smaller farmers, for example, by limiting the subsidy to a fixed quantity to be given per farmer, with the rest of the market being decontrolled. The Ministry of Agriculture is preparing proposals for extending subsidy to the farmers through direct cash transfer which is estimated to save 32% of total fertilizer subsidy, however, it has not yet materialized.

3.1.3. Prices

With the implementation of the nutrient-based subsidy (NBS) policy, the prices of DAP and MOP shot up during 2012–2013 to almost four times that of urea due to open market prices, resulting in overuse of urea and imbalanced NPK ratio (8.2 : 3.2:1). This reduces the grain to fertilizer response ratio, leading to much lower returns from fertilizer application.

3.1.4. Other government promoted interventions

Chemical fertilizers are subject to aggressive promotion by the government coupled with commercial salesmen. It is further associated with government-promoted interventions that include the introduction of chemical responsive varieties in crops like sugarcane, sunflower, potato, cotton etc. and most of the seeds and subsidies for these crops come with a package of fertilizers and pesticides. If one accepts the crop, one also has to accept the package to access credit that is linked to subsidy. Every time there is a crop loss or natural disaster, one of the first things government offers is free chemical fertilizers.

3.2. Production of customized and fortified fertilizers

Owing to lack of demand by farmers combined with commercial and economical constraints, (particularly the problem of procurement of raw materials), many manufacturers are not producing customized, blended and fortified fertilizers. The fertility status varies even from plot to plot due to variation in types of crops grown and inputs used. It is not possible to analyse every farmer's field for soil fertility purposes. Hence, fertilizer companies are preparing customized fertilizer grades based on nutrient indexing at district level but the larger the area under nutrient indexing, the higher will be the deviation from site specificity, making the results erroneous.

3.3. Quality assurance

Major areas of concern are the big range of complex fertilizers with nearly 50% of inert filler (concealed adulteration) and poor quality of micronutrient fertilizers. Fertilizer Quality Control portal's product wise sample analysis during 2012–2013 indicated that 71.4% of NPK mixtures, and 60% of micronutrient fertilizers were found to be non-standard (CFQCTI 2015). About 5% of straight fertilizers were found to be non-standard during 2013–2014 as per DAC (2015). Central Fertilizer Quality Control training Institute has regional laboratories at Pune and Indore respectively in Maharashtra and MP for conducting quality checks but there is a felt need to develop or nominate reputed agencies as referral laboratories to improve the quality of fertilizer testing and to increase sample size. The feedback tells us that the existing FQTLs (four in MP and five in Maharashtra) are not sufficient to handle large number of fertilizer samples. This is true in other states as well.

3.4. Diversion of fertilizers

Indian urea is the lowest priced in the large economies of the world coupled with lack of a proper regulatory mechanism is leading to the diversion of urea to non-agricultural uses that might range between 10–20% of urea distributed in the country. Urea is diverted for various industrial and commercial applications such as producing some types of plastics, glues, animal feed, plywood, automobile industry lubricants and pesticides within the country. MOCF officials say that there are cases of subsidized urea being siphoned off by manufacturers (largely in Maharashtra, Gujarat, Tamilnadu and Haryana) to mostly the chemical industry. Estimates suggest that at least 1 million tonne of urea is illegally diverted for industrial use. It is being smuggled into neighbouring countries (Bangladesh and Nepal) from states such as Uttar Pradesh and Bihar urea prices are higher in those countries. One proposal given by the Agriculture Ministry to control the black market is to make 100% urea neem coated instead of the current practice of 30% urea being neem coated, which may save INR 45 billion to the government by reducing the subsidy as well as the imports (TOI 2015). Neem coated urea is unfit for industrial use but is good for soil, crop and beneficial to the farmer through less wastage and less groundwater pollution. Further, officials reveal that a good chunk of potash, a key chemical entirely imported, is pilfered and diverted to the firecracker industries – or worse, repacked and exported. Lack of accountability and awareness among the famers that they would face action if they are caught selling subsidized urea to industrial units is another concern. Inflated sales are conducted compared to the actual requirement by fertilizer companies in connivance with some agricultural department officials, which leads to the sale of the fertilizers at higher prices on the black market when demand exceeds supply. However, subsidies are released to fertilizer companies only on certification (quantity, quality or transportation distance) from the local agriculture officers, so there are questions about the efficiency of the monitoring system.

The diversion of subsidized fertilizer to wealthier farmers also takes place but in negligible quantities. As the wealthy farmers perform agriculture on a commercial basis, they invest more in fertilizers by procuring them in advance in large quantities by assessing the demand during the sowing season. Thereby, their accumulation of fertilizers leads to more utilization of fertilizer subsidy and excessive application (sometimes more than required) compared to the small and marginal farmers. There are cases where the big farmers loan the fertilizer in kind to the poor farmers and charge interest on the estimated cost of the fertilizer.

3.5. Dominance of middlemen (distributors and dealers)

The fertilizer industry is well organized in terms of its distribution system. Farmers are not customers of the fertilizer producers, but rather customers (with the low bargaining power) of the local fertilizer dealers. Distributors remain under the influence of a few large producers who exercise the right to induce their market practices over distributors and the right to expel non-compliant distributors from their network. Sometimes, the fertilizer companies force the dealers to sell their other products such as bio-pesticides and complex fertilizers along with urea which puts a financial burden on the farmers and forces them to make use of unwanted or non-essential chemicals on their farms. The influence of middlemen (distributors) is negligible compared to the role of fertilizer companies as well as the regulatory mechanism. However, the local dealers heavily influence extension, thus driving the farmers to go for crops and fertilizers (type, quantity etc.) according to the dealers' choice and business requirement.

3.6. Soil testing constraints

Soil testing capacity of various MSTLs/STLs is about 10 million per year to cover about 138 million land holdings. The prevalence of smallholding systems of farming as well as a lack of infrastructure is a deterrent for extensive soil testing (Sen et al. 2008). Inadequate soil testing facilities means that farmers must travel far to get their soils tested and wait for a long time (1 to 4 months) to get the results and recommendations. Most of the farmers don't usually get their soils tested in the labs since they generally cannot understand the soil test results and don't know what parameters and measures that need to be taken to improve soil fertility. A study by Patel and Chauhan (2012) found that only 31% of the farmers had shown a favourable attitude while 37% had shown an unfavourable attitude and 35% were neutral in their reaction to the SHC programme. The lack of availability of sufficient number of qualified and trained manpower at STLs and among the extension staff is another concern.

3.7. Fertilizer use efficiency (FUE)

Soil organic carbon is important for the function of ecosystems, microbial population and agro-ecosystems having a major influence on the physical structure of the soil, its water holding capacity and its ability to form complexes with metal ions and supply nutrients. Depletion in soil organic carbon leads to poor FUE of the soil which on average is estimated to be 30 to 50% for N (due to immobilization, volatilization, leaching and denitrification), 15 to 20% for P (due to fixation), 70 to 80% for K (due to fixation), 8 to 10% for S (due to immobilization and leaching) and 1 to 2% for micronutrients (due to fixation) as per DOC (2015). The fertilizer product patterns, time and method of application of fertilizer, cropping patterns with no rational crop nutrition schedules and no site-specific nutrient management and faulty agronomic practices are aggravating the situation. Important links between use of fertilizers and other inputs such as improved seeds and irrigation against a set of varying agro-climatic situation are generally ignored when taking soil fertility decisions. Complex fertilizers which cannot guarantee the release of each nutrient according to the specific crop needs are hugely popular among the farmers due to the government policy and aggressive marketing by the manufacturers.

3.8. Resistance to use inorganic fertilizers

Although the majority of the farmers in most parts of the country always use chemical fertilizers, there is some resistance to their use in remote areas, especially where tribal farmers practice shifting cultivation or subsistence agriculture. Inorganic fertilizer consumption is very low in north-eastern states. Here farmers are reluctant, if not resistant, to use chemical fertilizers and adopt improved agronomic practices. Factors such as inadequate supply of and access to fertilizers combined with poor extension adds further to the apathy of the farmers towards the use of fertilizers. In arid areas and in the semi-arid tropics where rain-fed crops are grown, small and marginal farmers use very little chemical fertilizers due to lack of investment capacity and uncertainty of crop output or fear of crop failure due to unfavourable weather conditions. Recently with the onset of the sustainable agriculture concept, farmers who are aware of ill-effects of excessive usage of chemical fertilizers are opting to use inorganic fertilizers (farmyard manure [FYM]) and non-chemical pesticide management.

3.9. Adoption of conservation agriculture (CA) and Sustainable agriculture (SA)

For sustaining high productivity with NPK, integrated use of fertilizers with organic manure (farmyard manure at 10–15 t half year) is necessary under intensive cropping systems (Nambiar and Ahrol 1989). However, attitudinal change among the stakeholders is necessary to know the potential and adopt CA. The main limitations are: a lack of site-specific knowledge, lack of appropriate seeders especially for small/medium farmers, widespread use of crop residues for livestock feed and fuel, and burning of crop residues etc. Also, farmers prefer their lands to be prepared instead of going for zero tillage so that they can apply fertilizers. Small and marginal farmers who do not own livestock don’t have manures (except for some poultry manure) and compost. There is also lack of awareness and indifference among all stakeholders toward the negative impacts of the exclusive and excessive use of chemical fertilizers on soil properties, soil pollution and health and environmental issues. Moreover, chemical fertilizers are easy to transport and operate. Further, there are no subsidies for organic manures such as farmyard manure, compost and bio-fertilizers although certain schemes encourage their usage. Although there are some concerns among the farmers about the loss in soil quality when chemical fertilizers are used, the prospect of instant results in the form of high yields dominates their decisions. National Mission on Sustainable Agriculture has not yet taken off but is expected to bring an attitudinal change in farmers who are driven by markets and choice of crops rather than the soil health requirement.

3.10. Limited use of bio-fertilizers

The majority of farmers are not aware of bio-fertilizers. There is a supply of spurious products in the market with no proper quality checking mechanism and timely availability of standard quality bio-fertilizers, which can withstand high temperatures, is not yet streamlined. There is also a view among the extension agents and farmers that inconsistent results are reported on their use and farmers are not yet confident about the concept. Hence, dealers are also not keen to store and supply bio-fertilizers to the farmers.

3.11. Access to credit

Lack of access to credit and indebtedness pushes many farmers to purchase inputs from local dealers who often provide substandard inputs and whatever inputs they wish to sell. Maharashtra has registered highest farmers suicide deaths (2,568) against the total number of such deaths (5,650) in the country during 2014 and Madhya Pradesh reported 826 according to the official figures available (NCRB 2015). One reason for farm distress is lack of ownership records leading to lack of access to institutional credit and exploitation by the middlemen who charge exorbitant interest rates on the loans extended to farmers (apart from the stress from the frequent droughts and crop failures experienced). A number of co-operative societies also have weak financial status, hence requiring substantial credit to invest in procuring fertilizers for further distribution to the farmers.

3.12. Extension system

Loopholes in extension are leading to a wide gap in dissemination of knowledge about the benefits of soil testing and balanced fertilization according to the requirements of individual farmers. Less exposure of public extension officials to advances in crop nutrition has mean that officials have a limited focus on the subject. Small and marginal farmers and farmers located in remote areas do not receive much attention in the extension system in spite of certain initiatives by the government. Moreover, input dealers, who have narrow commercial interests have emerged as the main vehicle for technology diffusion. Private extension is useful and viable alternative for medium and large-scale farmers growing cash crops but is likely to discriminate against the poor, especially the passive poor.

3.13. Access to inputs and services

Physical access to inputs, services (infrastructure, credit, fertilizers and reliable information) and markets is required by improving rural roads and transport to play a positive role in improving the supply of inputs and services by private companies. Fertilizer transportation costs are currently borne by the government payable to the companies (eligible up to 1 400 km by trains and 500 km by road) but remote areas suffer as in case of north-eastern states and remote villages/blocks in all the states. In certain cases, additional charges over maximum retail price (INR 16 per 50 kg of urea) are collected from farmers by local dealers. Fertilizer companies transport the fertilizers in bulk up to one point and from there on, farmers have to pay additional charges of INR 30 to INR 50 per bag depending on the distance they are from the distribution point. Sometimes, fertilizer distributors resort to road transportation although train transportation is available as it is a convenient arrangement for them. Reportedly, fertilizer companies located in south India are demanding payment based on average cost of production instead of distance but companies from north India are favouring the present arrangement and a policy decision is yet to be taken on this by the government.

3.14. Social and economic inequality

Inequality in land distribution and insecurity of tenure, different forms of social discrimination and domination based on gender, caste and tribal affiliation affect the soil fertility management decisions at individual farm level. About 84% of the farmers in MP (marginal, small and medium) farm less than 10 ha land. In Maharashtra, the average size of a landholding is just 1.44 ha. The agricultural land diverted for non-agricultural (industrial, construction etc.) purposes is permanently lost, thus bringing under plough the marginal lands which are unsuitable for agriculture according to the land-use capability classification. These marginal lands are usually located in the ridge areas and are being distributed to the poor, thereby destroying the whole watershed catchment, thus aggravating the soil erosion and silting up the water bodies. Poor farmers have neither the knowledge of proper agronomic practices nor the required investment to suitably raise the crops, buy inorganic fertilizers or take soil fertility decisions. They lack access to manure and compost as well. There is resistance to the use of inorganic fertilizers in tribal areas, especially where primitive agriculture practices are being followed. Here, language gap appears to be a major problem for agriculture extension.

3.15. Coordination gaps in policy and implementation

3.15.1. There is a lack of coordination according to senior officials of DAC, DARE and DCF since schemes/programmes are usually implemented in parallel to each other without an orchestrated feedback mechanism. Combined reviews of related issues do not happen on regular basis to identify policy and strategy gaps and address the same in an appropriate way.

3.15.2. The absorption capacity of the states in terms of gearing up administrative machinery for developing strategies and use of funds varies a lot, hence the performance of SHM programmes of GOI also vary accordingly. For example, during 2015–2016, only 3.4 million SHCs have been issued so far out of a target of 8.4 million with states such as Andhra Pradesh leading (1.65 million SHCs) while quite a number of states (Arunachal Pradesh, Goa, Gujarat, Haryana, Kerala, Mizoram, Sikkim, Tamilnadu, Uttarakhand and West Bengal) have not distributed a single SHC so far and some states have not even started collecting soil samples. Tamilnadu and Punjab have exceeded their targets in soil sample collection but have not issued SHCs yet (*The Hindu* 2015).

3.15.3. Missing linkages among different agencies involved in agriculture related schemes implementation is clearly visible. Coordination between agriculture and watershed programme implementing agencies is either not strong (e.g. Maharashtra) or lacking (e.g. MP), thus we are unable to tap the watershed staff, funds and flexibility for soil fertility enhancement. The agriculture department also implements its schemes according to the administrative jurisdiction of staff and not on a watershed basis. At present, natural resource management and production enhancement components of IWMP are not focusing much on soil fertility management. Soil testing is prescribed on a sample basis in farmers' lands in all watershed villages but it is not strictly adhered to; even if sample soil testing is done, the results are not analysed properly to give recommendations and to do follow up. The productivity enhancement component received much less attention (less than 40% and 20% expenditure out of available funds in MP and Maharashtra respectively) though this component has an enormous scope for carrying out SHM-related activities. Ideally, the funds and staff of watershed and agriculture wings/departments must be pooled to carry out activities at block and district levels in coordination with each other.

3.15.4. Some of the observations of CSOs are that; (a) the efforts of the government so far have focused on creation of STLs and provision of soil health cards to farmers but the main concerns of improving fertilizer use efficiency have not been focused on (b) soil should not be disturbed as much as possible as context specific conservation agriculture reduces the cost of cultivation, hence saving farmers' money which can be used toward enhancing soil nutrition; but exactly the opposite is happening (c) combining livestock management in SHM programmes, (d) NMSA to be implemented and CSOs to be involved on a large scale in its implementation and (e) grass-root level NGOs to be trained in SHM to act as resource agencies in implementing various government programmes to improve access to soil health information by farmers.

CHAPTER IV

4.1. Types of training institutes

The training institutes are generally two types: formal education providers (agricultural universities) which transform the students with technical knowledge and equip them with formal certification. The second one is the technology upgrading institutes such as state training centres, KVKs, central and state agricultural research Institutes, which provide short-term, hands-on experience and refresher courses to the staff already employed with the government and other stakeholders concerned with implementation of agricultural programmes. Some state training institutes also offer diploma courses in agriculture/extension related subjects under the guidance of National Institute of Agricultural Extension Management (MANAGE).

4.1.1. Key training institutes

Table 7. Training/Education Agencies

Agency	Madhya Pradesh	Maharashtra
State agricultural universities (SAUs)	Jabalpur, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior	Agriculture Universities at Raluri, Akola, Parbhani and Dapoli
Agricultural technology information centres (ATICs)	Jawaharlal Nehru Agriculture University, Jabalpur, Bhopal and Raipur	Dapoli, Ahmednagar, Nagpur (CICR), Marathwada Agriculture University, Parbhani, Panjabrao Deshmukh Krishi Vidyalay, RahuriAkola

State-level agriculture training institutes	State institute of agriculture extension and training (SIAET), Bhopal with its 19 regional centres at Obedullaganj, Powarkheda, Betul, Indore, Satrathi, Jawra, Ujjain, Jabalpur, Narshingpur, Dindori, Varaseoni, Antri, Shivpuri, Morena, Sheopur Kalan, Sagar, Naogaon, Kuthalia and Singrouli	Vasanthrao naik state agriculture extension management training institute (VANAMATI), Nagpur with its seven regional centres at Amaravati, Kolhapur, Khopali, Nashik, Pune, Aurangabad and Nagpur
***Krishi vidya kendras* (KVKs) /Farmer knowledge centres**	47 nos; Datia, Ahoknagar, Burhanpur, Neemuch, Mandla, Badwani, Umaria, Sheopur, Dewas, Katni, Chhattepur, Shivpur, Hoshangabad, Morena, Sagar, Khargaon, Shajapur, Ujjain, Mandsur, Jabalpur, Harda, Damon, Narsingapur, Raisen, Dindori, Gwalior, Rewa, Betul, Panna, Dhar, Sehore, Bhind, Indore, Khandwa, Tikamgarh, Seoni, Rajgarh, Guna, Ratlam, Sidhi, Shadol, Balaghat, Vidisha, Satna, Jhabhua, Jabalpur, Bhopal.	44 nos; Buldana, Beed, Akola, Pune, Satara, Jalgaon, Latur, yavatmal, Gondia, Gadchiroli, Osmanabad, Raigarh, Bhandara, Hingoli, Nandurpur, Chandrapur, Amaravathi, Akola, Sindhudurg, Nagpur, Nashik, Parbhani, Kolhapur, Buldana, Nanded, Sholapur, Washim, Beed, Satara, Pune, Ahmednagar, Sangli, Jalna, Jalagaon, Aurangabad, Ratnagiri, Dhule, Wardha, Thane, Nashik, Solapur, Aurangabad, Ahmednagar, Nanded.

4.1.2. Agricultural universities

The SAUs provide formal education with certification in agriculture, horticulture and agri-business management. The technical knowledge and curriculums of these universities are on par with international standards. Broad guidelines on the curriculum are provided by ICAR and universities have the freedom to prioritize state specific subjects. However, the broad contours of the curriculum will be the same in all SAUs. In general, these institutes cover all aspects of soil and its management with up-to-date technology inputs. The syllabus under soil science and agronomy subjects covers SHM aspects in detail and practical experience is provided through study tours, RAWEP (Rural Agriculture Work Experience Programme) and interactions with scientists, farmers, entrepreneurs, input companies etc. Every major state has at least one agricultural university (two in MP and four in Maharashtra) to cater to the needs of the concerned state agriculture extension system. Maharashtra churns out maximum number (9,600) of graduates in agriculture related subjects as the state has 27 private agricultural colleges affiliated to the SAUs apart from the government colleges. MP does not have private agricultural colleges and produces about 700 graduates each year. Distant education courses are also offered in agricultural extension by YCMOU (Yashwantarao Chavan Maharashtra Open University) through its 45 study centres located in KVKs. These students get placements in state agriculture departments (although not on a regular basis), fertilizer companies, biotech companies, seed companies etc.

4.1.3. SAMETIs (State Agricultural Management and Extension Training Institutes)

SAMETIs are autonomous state institutes with a mandate to conduct training on agricultural technology, management, gender, extension reforms and information technology. SAMETIs also provide extension management inputs for extension functionaries of the Agriculture Department and conduct workshops, reviews and studies on extension gaps etc. Their technical knowledge and resource persons (serving or retired) come from universities and research institutes. MP’s State institute of Agriculture Extension Training (SIAET) located at Bhopal has 19 regional centres (some of them are attached to SIAET recently). The physical infrastructure at Bhopal is good but it is in poor shape in the regional centres. Maharashtra’s Vasantrao Naik state agriculture extension management and training institute (VANAMATI) is located at Nagpur and has seven Regional Agricultural Extension Management and Training Institutes (RAMETIs). The physical infrastructure is satisfactory at all the centres but there are not enough staff in the faculty to meet the training requirement. At all levels, the services of external faculty and resource persons are used.

4.1.4. Research Institutes and Extension Education Institute (EEI)

Every year, training courses are allocated by the Directorate of Extension to various research and training institutes and each state is allocated some seats. Research institutes also conduct training courses out of their own funds. Four regional EEIs organized 198 training courses (108 on-campus and 90 off-campus) with an allocation of INR 150 million during 2014–2015. Indian Institute of Soil and Water Conservation, Dehradun organized 8-day courses to train 170 officers and 113 watershed functionaries and one 4-month-long course on watershed approaches for 22 officers. Other research institutes also organized training courses in a similar way although the duration of the courses varies according to the requirement. The MANAGE coordinated Diploma in Agriculture Extension for Input Dealers (DAESI) module spreading over 52 Sundays (1 day a week in a year) gives authentic information on agriculture related aspects and imparts ethical values. So far, 580 input dealers have been trained in five states at a cost of INR 20,000 per trainee. States have different arrangements for financing the training. In Andhra Pradesh, 100% of the cost is borne by the trainees while in Jharkhand and Tamilnadu, state government contributed 75% of the cost from RKVY funds. States such as Orissa have subsidized the agri-clinics and agribusiness centres (ACABC) training courses (coordinated by MANAGE) by releasing INR 15,000 per candidate from

RKVY funds and the balance was borne by the candidates. The annual target is 12,000 for ACABC training although under DAESI, there are no fixed targets.

4.1.5. KVKs and ATICs

The main focus of KVKs is on farmers but they also organize training courses for extension personnel catering to specific themes as required by the state agriculture department subject to fund availability. KVKs utilize services of CSOs and some CSOs handle KVKs themselves. KVKs are farmer knowledge centres and they organized 61,495 training courses for 1.6 million farmers and extended mobile advisory services to 30, 752 registered farmers during 2013–14. During 2013–14, KVKs organized 5,430 training courses for a total of 11.8 million extension personnel. About 334 interface meetings were conducted during 2014 for scientists and district officials by ATICs to give AEOs an opportunity to interact with scientists and to gain knowledge on the latest technologies. However, regular training courses do not take place in ATICs. Some training courses deal with organic farming, sustainable agriculture and balanced nutrition.

4.2. Types of training activities

Skill development training courses are organized to train agriculture officials on subjects of special importance. Refresher training courses are organized from time to time to improve the quality of knowledge and in turn quality of work at state training centres, KVKs, agriculture colleges etc. The courses are designed based on the priorities of the state agriculture department. Special technical training programmes are designed to focus on specialized themes in relevant institutes. Extension reforms monitoring system of GOI requires SAMETIs to enter training details in its training information system.

4.2.1. Training courses

The SAMETIs offer short-term courses to existing extension staff on different subjects. The course calendars generally cover soil health management, fertilizer quality control, integrated nutrient management, soil and water conservation, fertigation, input management, fertilizer quality control, soil health and nutrition management, strategies to improve fertilizer and water use efficiency, watershed management etc. based on the priorities of the state agriculture department. Refresher courses of 3 to 5 days duration, for 30 to 45 individuals at a time are organized. The faculty of SIAET is mainly from Indian Institute of Soil Science, Bhopal in case of SHM subjects and in case of VANAMATI, experts come from Agriculture College, Nagpur. The curriculum is loosely structured for all the courses and it varies depending on the training centre and the availability of resource persons (Annex 4). The methodology mainly consists of expert lectures and field visits.

4.2.2. Number of training courses by SAMETIs

During 2015–16, SIAET planned 32 courses out of which six courses of 3 to 5 days duration are relevant to SHM and 21 training courses (30 per batch) were organized under these courses. About 480 extension officials of different cadres can be trained; the trainee attendance was around 75%. SIAET also organizes a 1-year postgraduate diploma course in agriculture extension management for ATMA functionaries in distance learning mode. This course has two semesters with 32 credits. Another diploma course is organized on agriculture extension services for input dealers (DAESI) to make them aware of technical issues in agriculture; this is important since dealers are an important extension channel in the country. A total of about 1,209 officials were trained during 2014–2015. Regional centres of SIAET also organize SHM training courses (roughly 400 trainees) but they are not well equipped from an infrastructural point of view. Regional centres are mostly focusing on integrated plant nutrient management system, farming system approaches for sustainable agriculture and diversified farming. VANAMATI planned to organize six courses (45 per batch) and 15 training courses on SHM related subjects. VANAMATI has six faculty members and services of external faculties are engaged on regular basis. On average, 14 training courses per month are planned. During 2014–2015, about 61 training courses were conducted to train 1,549 officials with average attendance of 74%. RAMETIs train about 300 officials on SHM courses. In each regional centre, one soil-testing officer is positioned to focus on soil fertility issues. The services of CSOs are mostly used in providing resource persons in organic farming and sustainable agriculture. Sometimes, funds are provided to CSOs to organize/facilitate training courses, especially on the above two themes.

4.2.3. Course content

SIAET organized 21 training courses covering six courses on SHM-related subjects; dryland farming, SHM and INM, organic farming and policy, IWMP, sustainable agriculture and quality control of fertilizers. Two courses of horticulture management were organized in horticulture crops management where one session focuses on crop nutrition and one TOT (training of trainers) is also planned. About 13 training courses covering six courses; drip irrigation and fertilization, micro-irrigation and fertigation, organic farming and certification, participatory watershed management, quality control and legal provisions for agricultural inputs, soil and water conservation treatments, were organized by VANAMATI.

4.2.4. Training inputs on SHM

Agriculture department officials report that soil (not water) is likely to be a more talked about subject in the future, hence there needs to be a focus on SHM. Various aspects of SHM are touched on in the training courses and the best approach is considered to be a mix of organic and inorganic nutrition combined with good agronomic practices for restoration of soil health. Chemical fertilizers are discussed as part of crop management and soil nutrition but there is no specific promotion of them in the training courses. There is knowledge of farmer soil management strategies, which is discussed during teaching though it does not find a place in the formal curriculum except in organic farming and sustainable agriculture. The techniques for improving organic matter and soil biodiversity are also taught. Conservation farming is not a favoured topic as the faculty members or the trainees don't have any strong belief in the subject. However, while teaching organic farming and sustainable agriculture subjects, some aspects of conservation agriculture are covered. Soil testing and quality of soil testing are taught in the respective courses. Training institutes also have good interface with SAUs and central and state research institutes which helps in obtaining the latest information on research. There are soil testing labs and officials to teach the soil testing skills in-house in RAMETIs in Maharashtra where as other training centres provide that training at the nearest available government STL. The theme content is similar for similar training courses in all the states although the content varies a bit. Training is mostly confined to the immediate needs of the agriculture department and agriculture issues in respective states rather than the country as a whole. Trainees attend short study visits and interact with scientists, farmers and companies depending on the course requirement. Where required, discussions take place on soil information systems such as farmers' portal, from where information on availability of fertilizers, details of private service providers etc., can be obtained.

4.3. Private training institutes

Some CSOs, growers associations and fertilizer companies have training facilities but training courses are mostly conducted for farmers, input dealers and their own staff; very rarely, agriculture department officials undergo training conducted by private organizations. However, there are some links between the respective state government and private organizations. Sometimes, state governments sponsor the training courses to be facilitated by CSOs, especially on subjects such as sustainable agriculture and organic farming. CSOs are considered to be good at adopting suitable training methodologies and their services should be used more often. Sometimes, experienced CSO personnel are utilized as resource persons to take certain sessions in the training activities organized by government training institutes.

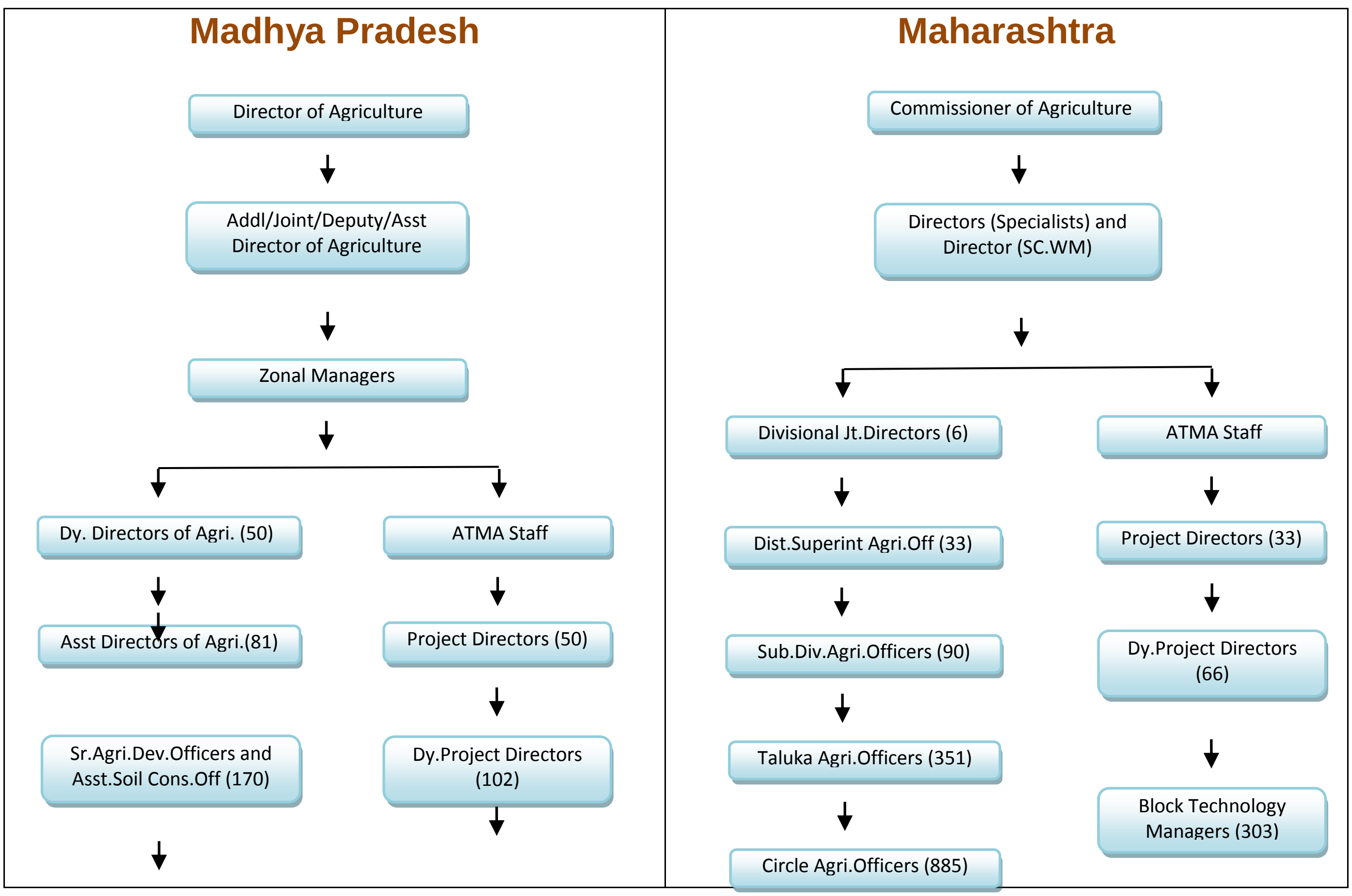
4.4. Extension personnel

The total extension cadre is about 143,863 positions in the Department of Agriculture in all the states put together. The ratio of farmers to extension workers is as low as 1,000:1. This ratio is also not effective because at least 25% of extension workers are administrators/ supervisors who are not directly in touch with farmers (GFRAS 2012). Under programmes such as the Agriculture Technology Management Agency (ATMA), there is provision for recruiting extension staff on a contract basis. There are 5,618 blocks in 640 districts of the country where ATMA is implemented.

Each block technical team (BTT) consists of one BTM (block technical manager) and three ATMs (assistant technical managers) with graduate/diploma academic qualifications in agriculture, horticulture, organic farming, seed technology, plant protection, botany etc. The BTT is assisted by farmer friends at village level (one for every two census villages) who could be progressive farmers with senior secondary/high school qualifications. BTM and ATM are paid INR 15,000 per month and INR 5,000 per month respectively while farmer friends are paid up to INR 6,000 per annum to meet contingency expenses. Farmer friends take part in mobilization of farmers, constituting farmer groups, organizing field demos and prepare a village research extension plan. This is the most important link in the public extension system.

Subject matter specialists working at directorate level in the agriculture department are expected to keep continuous contact with agricultural research stations and SAUs to discover research developments to train the extension workers on the latest farm technologies and help them in solving field problems. Extension officials need to understand the problems of farmers, undertake farmer educational activities by conducting meetings, demonstrations etc. and provide advisory services to farmers. They need to have knowledge and skills in general agriculture and as well as in other aspects of agricultural development such as credit, input supply and marketing.

4.4.1. Status in MP and Maharashtra



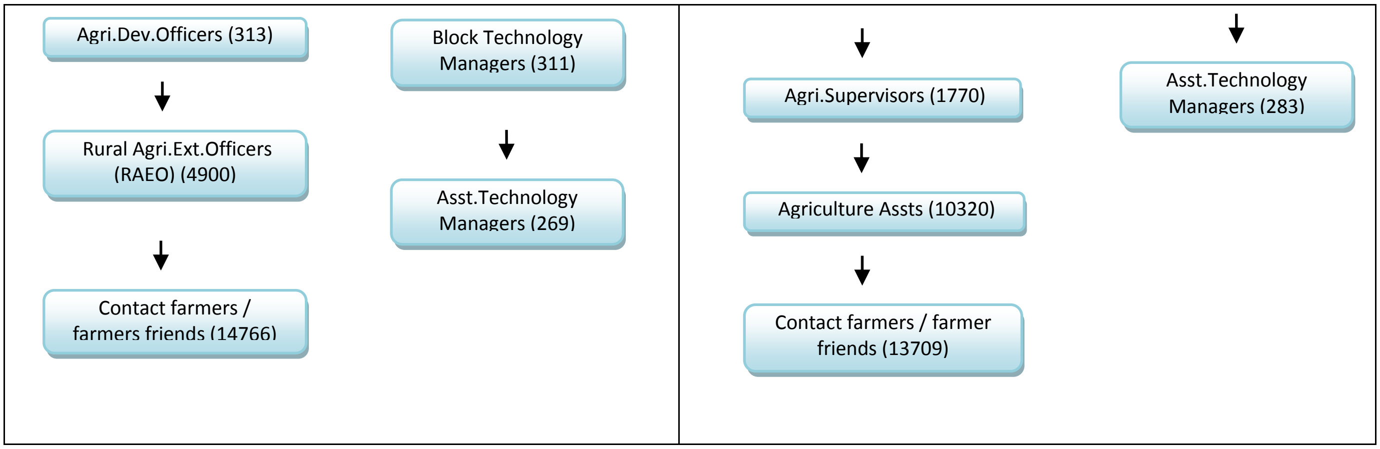


Figure 3. Organization structure of state agriculture departments in Madhya Pradesh and Maharashtra.
Source: Department Farmer Welfare and Agriculture Development, MP and Department of Agriculture, Maharashtra

The district is an important unit of administration, which is managed by one senior officer assisted by subject specialists to guide and monitor agricultural programmes. From an extension point of view, a block is an important administrative unit with extension officers of the department assisted by ATMA officials at block level and farmer friends at village level. Maharashtra has more agriculture extension officials than MP, whose emoluments are met from the state exchequer. The number of ATMA positions sanctioned between two states is not that different as the positions are sanctioned by GOI based on the number of blocks. About 43% in MP and 42%, of the sanctioned positions in Maharashtra are filled, apparently due to low emoluments and the temporary (contractual) nature of the job.

Table 8. Extension Personnel Status in MP and Maharashtra

Details	Madhya Pradesh	Maharashtra
Gross sown area (ha)	22,046,000	24,069,000
No. of farm households	7,800,000	13,700,000
Extension personnel (from sub-division to the lowest level)	6,146	14,068
No. of farmer friends	14,766	13,709
Gross sown area (ha) per each extension worker		
a. Excluding farmer friends	3,587	1,710
b. Including farmer friends	1,054	867
No. of farm households/extension workers		
a. Excluding farmer friends	1,269	974
b. Including farmer friends	373	493

Source: Department farmer welfare and Agriculture Development, MP and Department of Agriculture, Maharashtra

Table 8 shows that MP and Maharashtra have almost similar extent of gross sown area but the number of farm households is very high in Maharashtra. Maharashtra has better public extension outreach than MP. However, there are more farmer friends in MP, thus increasing the contact intensity. As it could be very difficult to create more positions for extension officials on a permanent basis by the government due to the enormous establishment costs, a more practicable solution is; selecting right farmers as farmer friends, training them appropriately, utilizing their services at optimum level by monitoring their activities effectively and giving incentives to good performers among them. As such, various evaluations also indicate that farmers are the best source for extension besides mass media.

4.4.2. Technical knowledge

At any given time, 30–40% of positions are vacant in the extension system, which increases the pressure on existing functionaries. Further, they are preoccupied with implementation of a number of state and central programmes focusing on input and subsidy delivery. Farmers living in widely dispersed communities and remote areas can be difficult to reach with the same pattern of staff deployment. In fact, the feedback tells us that well performing officials at the field level are not sent to undergo training courses as their services are essential for delivering the above services. The lowest level functionaries have meagre allowances and no incentives, hence it does not provide a proper environment for giving technical inputs to improve their static knowledge.

The inefficient agricultural extension system has resulted in a wide gap between research and knowledge implementation in SHM. Extension functionaries do not have sufficient knowledge about the optimum nutrient requirements as not everyone undergoes training courses in SHM and they need continuous knowledge inputs to refresh themselves on the latest technologies and developments in SHM. Although some extension officials are found to be learning and delivering the latest information to the farmers, generally the farmers report poor delivery. Extension officials need to be familiar with the latest technology but the meagre training inputs they receive in training courses or review meetings is not sufficient to meet their requirements.

4.4.3. Constraints

Most marginal and small farmers fall into the non-receivers category and the extension machinery (public and private) does not make much effort to reach the passive farmers, which is the biggest gap in the extension system. There needs to be more focus in bridging the gap in the attitude of the public extension system, and training institutes should gear up to handle this situation.

Funds are not a major constraint to conducting more training courses though funding is required for improving infrastructure and faculty strength at state training institutes and their regional centres. Training institutes design their training calendar based on: which scheme can fund them, what are its priorities and what are the state agriculture department's priorities etc., rather than what is actually required in the field and what issues have to be handled immediately. The training needs of the individuals also might not match with the content of the course module. The needs of the outreach vary based on the total area under crops, types of crops (cash crops or food grains crops), irrigated/dryland agriculture, types of farmers (small, marginal, medium or large) etc. Mostly the focus is on plant protection, seeds, fertilizers, technology and marketing but very less attention is paid to soil health related information, especially soil testing and interpretation of the soil testing results.

The training is focused on a few topics but does not discuss the problems faced by farmers such as access to fertilizers soil management options as the training institutes think that these are issues that should be handled by the state agriculture department. Even if the faculty has an understanding of the issues at field level, they mostly give technical inputs according to the prescribed course structure. The training group consists of all cadres of agriculture officials. ATMA staff members come from different backgrounds and might not have a formal degree in agriculture. Most of the training courses are just for 3 to 5 days; they can only orient or refresh the knowledge of the trainees; it is not possible for trainees to fully imbibe the knowledge in this time. Continuous training of agriculture extension workers is essential but this is not possible in the current setting.

It is not the training courses but constant persuasion and monitoring from senior staff that help the officials to focus on SHM. State agriculture departments need to attach importance to providing quality training courses in SHM by mainstreaming it as a core area rather than viewing it as the mandate of SAMETIs. Each state should have strong policy and strategy to meet the training needs of the agriculture extension staff. To offset the disadvantage of lack of sufficient physical infrastructure and human resources, training courses can be outsourced to selected CSOs and other relevant agencies, which can also improve the qualitative aspects. Stronger links between training and research institutions are required to get practicable applications of research knowledge through increased interaction. Also, farmer friends are the most important village level links in the ATMA system because of their accessibility that helps them to increase the contact intensity. Hence, training courses and exposure visits should be conducted for farmer friends by using various approaches and methodologies and building monitoring systems so that quality information can reach as many farmers as possible.

CHAPTER V

5.1. National level training programmes

Under Extension and Training, INR 6.25 billion is allocated for 2014–2015, which includes support to the central institutes, mass media support, ATMA, provision of model training courses, agri-clinics and agri-business management course (ACABC) etc. National training programmes are organized by the Directorate of Extension (with its regional centres at Nilokeri, Hyderabad, Anand and Jorhat) of the Ministry of Agriculture. Seats are allotted to each state according to their needs, in the government training centres and ICAR institutes. Model training courses of 8 days duration on core areas of agriculture are supported by the DOE with the objective of improving trainees' professional competence and upgrading their knowledge and developing their technical skills (Annex 5). Summer school and winter school courses on conservation agriculture, sustainable agriculture and INM focus on training the scientists, faculty of training institutes, SAUs and senior government staff, include farmer strategies. Two-day training courses for the staff on orientation and extension courses with half-a-day of field demonstration are common and they contain one session on soil related matters. Refresher courses are usually organized for 2 days and some research institutes also offer training courses on soils and soil management related aspects.

Table 9. Research and Training Institutes

National level	Activities/Remarks
ICAR-IISS (Indian Institute of Soil Science), Bhopal with regional centres at Jabalpur and Nagpur	Works on technologies to sustain soil health, conservation tillage for soybean, broad bed furrows, organic farming practices for various crops and cropping systems
Central Soil Salinity Research Institute (CSSRI), Karnal with regional centres at Agra, Bapatla, Bikaner, Gangawati, Hisar, Indore, Kanpur and Tiruchirapalli	Adopts villages in the short term to make front-line demos and conduct travelling workshops to test their technologies and learn from farmers for research purposes; produces publications in local languages
Central arid zone research institute, Jodhpur	Three KVKs and one ATIC give a good interface for taking knowledge from farmers and feeding it into the research system of CAZRI; organizes sensitization workshops
Indian Institute of Soil and Water Conservation (IISWC), Dehradun	Works on agronomic techniques by incorporating farmers' practices
ICAR-NBSS and LUP (National Bureau of Soil Survey and Land use planning), Nagpur	Collects, collates and disseminates information regarding soil survey and land-use planning. Takes up special projects at field level and imparts training courses to scientists and officials
Soil and Land Use Survey of India (SLUSI), Delhi	Detailed soil survey, land degradation mapping, soil information for data banking is made available to the states; special projects are taken up in states according to requirements; specific

	training courses are organized
ICAR-CRIDA (Centre for Research in Dryland Agriculture), Hyderabad	Documentation of vast soil health knowledge of dryland agriculture farmers (who are the most adapted to droughts) through regular scientist-farmer interaction to test and authenticate these practices in research outcomes.
National Centre for Organic Farming (NCOF), Ghaziabad with regional centres at Jabalpur and Nagpur Bangalore, Bhubaneswar, Hisar and Imphal	Promotion of organic farming in the country through technical capacity building of all the stakeholders including human resource development, development of organic package of practices (most of which have inputs from farmers) and transfer of technology
National Institute of Agricultural Extension Management (MANAGE)	Provides training support to senior and middle level functionaries of the state governments besides conducting a postgrad. diploma course for public extension functionaries, agri-clinics and agri-business centres (ACABC) and diploma in agricultural extension services for input dealers (DAESI) training courses
ICAR-NAARM (National Academy of Agricultural Research Management), Hyderabad	Trains ARS (agriculture research scientists), conducts postgrad. diploma courses in management–agriculture (2 years) and technology management (1 year). Training inputs are taken from various institutes for incorporation into their curriculum
Indian Agricultural Research Institute (New Delhi), Central Institute of Cotton Research (Nagpur), Central Rice Research Institute (Cuttack), Indian Institute of Oilseeds Research (Hyderabad), Indian Institute of Pulses Research (Kanpur), National Research Centres for; Citrus (Nagpur), Grapes (Pune), Pomegranate (Solapur), Directorate of Research for; Rice (Hyderabad), Soybean (Indore), Onion and Garlic (Pune).	These centres and directorates of various crops carry out soil research for better management of respective crops and they work in close coordination with farmers to understand the research needs as well as farmer practices and take feedback in developing technologies and strategies which become research outputs

Several small research projects also are also being taken up with the funding of ICAR provided by state agricultural universities (SAUs). The findings of these research institutes/projects are transferred to the state departments of agriculture after testing at appropriate locations for adoption and popularization. Farmers’ interactions with scientist are regularly organized by SAUs to help the scientists understand and acquire information on farmer practices. Each ATIC functions as a “single window system” to help farmers and other stakeholders such as extension workers, private organizations and CSOs, in providing solutions to their location-specific problems and give support to the ATMAs in technology dissemination. Innovative farmers’ meetingss, stakeholder consultation workshops and interaction forums with farmers help in giving required feedback to research and training institutes. MANAGE works through CSOs; *Sarashwath sethi vikas pratishtan, Shriram Pratishtan mandal* and Krishna Valley Advanced Agriculture Foundation, selected KVKs and other government institutes in Maharashtra and Indian Society of Agri-business Professionals and Institute of Cooperative Management and Agriculture University, Jabalpur in MP to conduct ACABC training. In ACABC training module, there is no special focus on soil testing and SHM but certain sessions and exposure visits are included. So far, 41,734 persons have been trained under ACABC out of whom, about 40% established agri-ventures till 2014. MANAGE was given a target of conducting 208 training courses and 60 MTCs with an allocation of INR 240 million. The self-financing 1-year distance education course, DAESI, is also organized by MANAGE to cater for the agriculture extension requirement (Annex 6). There is no consolidated information on how many training courses have focused on SHM but rough estimates say that it is not more than 5%.

5.2. Farmer soil management strategies

Farmer soil management strategies can be categorized under the themes: adding more nutrients into the farm system (e.g. regular application of 8 to 10 t FYM per ha to supply organic matter); minimizing unproductive losses of nutrients from the system (e.g. certain agronomic practices); maximizing the recycling of nutrients within the farm (e.g. ploughing back the crop residues into the soil to supply K); and increasing the efficacy of nutrient uptake and using soil amendments to improve soil fertility and soil biophysical properties.

5.3. Two-way process

Farmers are reached by KVKs, ATICs and SAUs who take essential feedback from farmers' experiences and pass it on to the research and training institutes. Subject matter specialists at agriculture department directorate level are expected to share current recommendations and findings related to farm production and management by maintaining continuous contact with agricultural research stations, SAUs and provide feedback to the research system about farmers' problems. Research and training institutes also use farmer field schools, telephone query system and mass media interactions for taking information from farmers on their knowledge and requirements. They use the knowledge and experience gained to investigate and develop new approaches of soil nutrient management that benefit farmers.

5.4. Incorporation of farmer strategies in training courses

The feedback from research and training institutes is that the research outcome from the above two-way process is incorporated in training programmes relevant to SHM. Farmers have knowledge of fertility indicator plants, soil drainage, soil texture, reasons for stunted growth, soil type, soil salinity, water holding capacity, “where-what crops”, soil colour, soil biological activity, soil smell etc. They also have knowledge of management practices for soil nutrition and agronomic interventions. At research level, this could be in the form of technology interventions or a package of practices. However, the training material or curriculum does not indicate the links to farmer strategies. Also, the terminology is scientific, so it is difficult to make out the inputs from farmer strategies except in the case of organic farming and sustainable agriculture training courses, (which use the farmers’ knowledge to a great extent and terminology to a lesser extent). Links among different research and training agencies dealing with soil related issues for creating a comprehensive platform to document, share and acknowledge the farmer strategies are required. There is also a need to restructure agricultural curriculums and pedagogic methodologies to incorporate farmer soil management strategies.

CHAPTER VI

In India, there are about 138 million small landholdings and the number is growing year by year. According to some estimates, a public extension person spends an average of 40 minutes per year on each farmer (Dileep kumar 2012). With this kind of minimal contact intensity, a complementary service is needed by the country’s farmers. India has about 980 million telephone subscribers and 300 million Internet subscribers. So, innovative methods are added to agriculture extension system involving mass transfer with one-way or two- way transfer of technology by government (on its own or in public-private partnership mode) and private organizations in mobile and Internet media. Important initiatives with respect to soil information delivery are mentioned below.

6.1. Government initiatives

National e-governance plan in agriculture (NeGP-A) aims to achieve good outreach in the agricultural sector through ICT-enabled multiple delivery channels such as the Internet, government offices, KVKs, Kisan call centres (KCCs), agri-clinics, and mobile phones for providing integrated ICT-based services to farmers. Knowledge-based information is being provided to farmers through a number of Internet- and mobile-based applications including the farmers’ portal, mKisan portal and KCCs. At least 80 portals, applications and websites have been developed by the Department of Agriculture and Cooperation (DAC), primarily in collaboration with National Informatics Centre.

6.1.1. Kisan call centres (KCC) was launched by DAC in 2005 to deliver extension services in 22 local languages to the farming community across the country by responding instantly to the issues raised through an effective call centre service based on a dynamic database and regularly updated knowledge by linking farmers to experts in the research and extension system. These services were relaunched during 2014 in association with IKSL (IFFCO Kisan Sanchar Limited) with a total revamp of the infrastructure, constitution of state-level monitoring committees and strengthening of knowledge management system for KCC agents. Calls are toll-free and are handled in two categories. Roughly 0.6 million calls are made per year. Level 1 agents answer most of the calls. On Level 2, subject matter experts answer the more difficult items within a prescribed number of hours. The queries include information relating to fertilizer application, sourcing of quality inputs and credit. The KCCs function from 14 locations: Ahmedabad, Bengaluru, Bhubaneswar, Chandigarh, Coimbatore, Guwahati, Hyderabad, Jammu, Jaipur, Jabalpur, Kanpur, Kolkata, Patna and Pune which are accessible by dialling a single nation-wide toll free number 1800–180–1551 through the landline as well via mobile phone (all networks) from 6.00 a.m. to 10.00 p.m., 7 days a week including holidays.

6.1.2. Farmers' portal is an excellent initiative for providing top-down information on STLs, soil testing reports, state and fertilizer stock availability, wholesaler and dealer network details by integrating with websites and portals of relevant departments and institutes (Department of Fertilizers, IISS, DAC, mKisan etc.) on a single platform (one-stop-shop for farmers). There is a link to an exclusive SHC web portal that was launched in July 2015, which allows for registration and collection of soil samples along with testing in approved labs. Information on different crops is available on the portal and it builds up a database on soil health for future use in research and planning.

6.1.3. MKisan extends mobile-based services for farmers and other stakeholders through government organizations working up to the block level. The farmers registered for receiving SMS messages are grouped based on the blocks, crops and activities selected by respective farmers.

6.2. Private initiatives

There are several private initiatives which charge cost for services and some offer free services. However, almost all initiatives cater to the general needs of the farmers and soil information services may go as part of the total package only. *Digital Green* in collaboration with CSOs like BAIF and PRADAN disseminates agricultural information to the small and marginal farmers through digital videos by accessing the library and using films sequentially to build farming capacity over time. Another Internet-based discussion portal aAqua provides an open forum with SMS as an additional service. The users have created more than 90% of the content themselves, uploading text, photographs and videos to the site. A farmer can ask a question on aAqua from a kiosk or cyber café; other farmers or experts view the question and reply (in English, Hindi or Marathi). A fee-for-service application of Tata Consultancy Services mKrishi combines multiple technologies to bring information on fertilizer requirements based on soil conditions and soil and water conservation to the farmer's low-end mobile handset in Maharashtra pilot projects. It allows farmers to send queries, images and voice-activated SMSs (to help illiterate farmers) and provides customized responses in relevant language within 24 hours.

6.3. General observations

An evaluation study asserts that farmers aged 29 to 48 years were the biggest user group of the KCC helpline. In terms of academic background, farmers with a minimum exposure of 6 to 7 years to formal schooling and relatively inexperienced farmers with less than 10 years of experience were the ones who utilized KCC support most (Hanumankar 2011). This shows the broad outline of the type of farmers using mobile applications, necessitating effective extension of these services both in government and private domains. Internet-based solutions may not be very accessible to the majority of the semi-literate and illiterate farmers although one third of total Internet connections are located in rural India but voice and visual applications can receive a good response. The limitations in these applications are: impracticality of advice provided by the point persons due to obsolete or limited knowledge and inability to comprehend local accents and dialects, delayed access to experts, lack of awareness about these services among the majority of the farmers and poor telecom and Internet connectivity, particularly in remote villages. Often, private initiatives do not get scaled up and remain as pilots. The government, with its wide network of physical and human infrastructure coupled with its capacity to invest in soil information related subjects is the best soil information provider besides the mass media, especially to the small, marginal and medium farmers but the government needs to fully gear up its machinery to achieve its objectives.

Chapter VII

Summary

The major factors affecting the soil fertility decisions of the farmer are: fertilizer availability (suppliers, price); crop choice (availability of inputs); FYM availability (availability of livestock and grazing lands); crop residues availability for livestock and mulching; and knowledge of soil fertility and transport facilities. Hence, either the government machinery or CSOs working in the sector should examine these factors and improve the existing situation.

7.1. Role of the government

The government approach should examine: the harmonization of databases and relevant funding schemes for utilization of the funds on time through effective convergence strategies; and addressing soil health needs through differential policies for big and small farmers by carrying out the required mapping and regulating the quality of private services. A better policy instrument would be to make it possible for farmers to access credit so they can purchase whichever form of fertilizer (FYM, bio-fertilizer, vermin-compost or chemical fertilizer) they want. This would go a long way in helping small and marginal farmers to steer clear of purchasing chemical fertilizers because they are the only inputs available on credit.

Soil fertility maps developed through soil surveys and broad soil sample testing analysis are no substitute for individual soil analysis-based fertilizer recommendations which consider the cropping systems, level of fertilizer use in previous crops and management level of individual farmers. Instead of just increasing the number of STLs, the establishment of new STLs with quality equipment and properly trained personnel is very important. The STL unit could also engage in providing guidance to the farmers in the areas of land reclamation, compost-making, use of bio-fertilizer etc.

Quality checks on fertilizers and soil testing is essential for increasing the credibility of SHM schemes. Fertilizer subsidies must be comprehensively re-examined to provide balanced nutrition and ensure that more of subsidy goes to the smaller landholdings – for example, by limiting the subsidy to a fixed quantity to be given to each farmer, with the rest of the market being decontrolled. Agricultural extension needs to be strengthened by increasing the number of extension personnel, enhancing the technical knowledge of the AEOs and farmer friends and emphasising that SHM is the most important issue for farmers and can’t be ignored any longer.

7.2. Scope for CSOs

The gaps in the existing set-up need to be studied in specific states and specific locations within the states to provide any meaningful interventions. The government has a huge presence, but it is limited in critical areas of extension and training. Private agencies/information services don't really address SHM in a holistic way as they focus mostly on crop productivity enhancement and SHM activities (e.g. soil water conservation, safe use of fertilizers and pesticides etc.). It is here that responsible CSOs need to play a key role in bridging the gaps. Further, they need to bring in much-needed quality in various aspects by imparting knowledge to the stakeholders through training courses and capacity building activities. State specific strategies have to be evolved at a broader level for shifting the immediate focus of farmers from merely getting instant yields to getting sustainable yields. For example, Maharashtra has very high number of farmland holdings and more area under commercial crops with the presence of strong farmer associations and input companies, whereas MP is more open to CSOs in encouraging organic farming and building collaborations with CSOs.

Schemes and associations: Schemes with scope for involving CSOs in taking up SHM and related extension activities are: RKVY, NMSA, ATMA, IWMP, SHC and NFSM. Good rapport should be built with the Agriculture Department and provisions available under different programmes need to be studied in detail to ensure that available funds are utilized properly and don't lapse towards the end of the financial year. Building strong associations with relevant research and training institutes such as KVKs, ATICs, SAUs and state training institutes is essential for updating the technical knowledge of CSO staff so as to provide the knowledge to farmers and farmer friends in an appropriate way.

Training and extension needs: These needs have to be attended on a top priority basis through: demonstrations, farmer field schools; exposure visits; facilitating relevant training courses on SHM and acting as resource agencies; playing a role in improving the course syllabus; engaging the AEOs working at the cutting edge level for imparting technical knowledge in crop nutrition; focusing more on farmer friends; and training the grass-root level CSOs. Investment in human resource development is important to facilitate attitudinal changes among the farmers so that they can make right decisions on soil fertility and adopt sustainable agriculture practices. Training courses such as DAESI can be facilitated to impart technical knowledge and inculcate ethical values among the input dealers. Collaborations/associations with growers/farmers associations, input companies and independent entrepreneurs must be developed for making appropriate interventions. There should be a focus on: remote and inaccessible areas, tribal areas, language barriers and poor and passive farmers. The facilities of the mass media and CRS (if already existing) can be utilized effectively; even establishing a new CRS can be considered, if required.

Village platform: Farmer SHGs, women SHGs and their federations, Panchayat Raj Institutions (PRIs) which are important for village administration and watershed associations/committees need to be brought together on a common platform so that information can be accessed in an effective way. Small and marginal farmers need to be grouped together in viable units for imparting knowledge and farm distress counselling needs to be taken up as part of outreach activities in adverse situations.

Agronomic practices and choices: Crop choices must be based on soil suitability and water availability subject to the existence of congenial meteorological conditions. The farmers choice of crop varieties, proper agronomic practices to improve soil organic matter and soil structure, conservation agriculture, sustainable agriculture, agroforestry measures, combining livestock management with agriculture, composting, bio-fertilizers, micronutrients, precision farming (in the case of horticulture crops), reducing the cost of cultivation, FUE enhancement etc. An understanding of inter- and intra- district variation (fertilizer consumption, ST facilities etc.) is essential to attend to the local problems in selected pockets. There must be awareness of micronutrient deficiency, unfavourable NPK ratio due to imbalanced nutrition and the ill-effects of excessive usage of urea and complex fertilizers.

Soil testing: Efforts are required in: facilitating the collection of the correct samples at the right time, communicating the results on time, interpreting the results in an appropriate way so that farmers can comprehend the issues, enhancing the technical knowledge of STL staff and linking them with the field requirement. Above all, making the soil testing to go along with the regular package of practices to mainstream it (if a sufficient no. of STLs is established in the near future) is an important task.

Soil health information: Efforts should be made to link farmers with available soil health information channels such as: farmers' portal, mKisan, Kisan call centres, mass media, community radio stations, KVKs and private initiatives so as to increase the outreach and contact intensity. Interventions can be made to improve the quality of the information disseminated through these channels as well.

Access to credit: Access to credit can be improved through initiatives such as establishing farmer groups, women SHGs and their federations and linking them with the banks and cooperatives. Certain examples of collective efforts (BAIF initiative in Maharashtra) for cutting down the cost of cultivation through collective procurement of inputs and reducing the marketing costs through collective procurement of the produce can help in building the confidence of the farmers in CSO initiatives that can be used to focus on SHM.

Watershed links: Watershed institutions should be fully aligned with the agriculture departmental activities in watershed project areas where CSOs are acting as PIAs or resource agencies so as to bring synergies through combined strength of watershed and agriculture functionaries. Natural resource management, institution and capacity building and productivity enhancement components of the watershed projects need to be explored to utilize the funds properly to bring in required SHM initiatives and take up training and capacity building activities.

Advocacy: CSOs need to take up strong advocacy measures by giving feedback from their experiences to the government at different levels on appropriate forums and by bringing CSO networks together to discuss and lobby for positive changes in the policy environment which could help in revisiting the existing policy and implementation framework in soil health management.

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Annexes

ANNEXURE 1

Annexure 1 (a): Per Kg Nutrient Based Subsidy (NBS) rates for nutrients NPKS

NBS rates (Rs. per Kg)		
Nutrients	**2013-14**	**2014-15**
'N' (Nitrogen)	20.875	20.875
'P' (Phosphate)	18.679	18.679
'K' (Potash)	18.833	15.500
's' (Sulphur)	1.677	1.677

Annexure 1 (b): Per MT subsidy on different N, P, K & S fertilizers

S. No.	Fertilizer Grades (FG)		2013-14	2014-15
1.	DAP	(18-46-0-0)	12 350	12 350
2.	MAP	(11-52-0-0)	12 009	12 009
3.	TSP	(0-46-0-0)	8 592	8 592
4.	MOP	(0-0-60-0)	11 300	9 300
5.	SSP	(0-16-0-11)	3 173	3 173
6.	16-20-0-13		7 294	7 294
7.	20-20-0-13		8 129	8 129
8.	20-20-0-0		7 911	7 911
9.	28-28-0-0		11 075	11 075
10.	10-26-26-0		11 841	10 974
11.	12-32-16-0		11 496	10 962
12.	14-28-14-0		10 789	10 323
13.	14-35-14-0		12 097	11 630
14.	15-15-15-0		8 758	8 258
15.	17-17-17-0		9 926	9 359
16.	19-19-19-0		11 094	10 460
17.	Ammonium Sulphate (20.6-0-0-23)		4 686	4 686
18.	16-16-16-0 (w.e.f. 1.7.2010)		9 342	8 809
19.	15-15-15-9 (w.e.f. 1.10.2010)		8 909	8 409
20.	24-24-0-0 (from 1.10.10 to 29.5.12		9 493	9 493
20.	and w.e.f. 22.6.2012)			

21.	DAP Lite(16-44-0-0) (w.e.f. 1.2.11)	11 559	11 559
22.	24-24-0-8 (wef 12.11.13 to 14.2.15)	9 493	9 493
22.	without subsidy on S		

Source: Department of Fertilizers, MOCF.

ANNEXURE 2

Annexure 2 (a): Popular Fertilizer Mixtures Grades (N, P, K, S) in India

DAP (18-46-0-0)	**MAP (11-52-0-0)**	**TSP (0-46-0-0)**
MOP (0-0-60-0)	SSP (0-16-0-11)	16-20-0-13
20-20-0-13	20-20-0-0	28-28-0-0
10-26-26-0	12-32-16-0	14-28-14-0
14-35-14-0	15-15-15-0	17-17-17-0
19-19-19-0	Ammonium Sulfate (20.6-0-0-23)	16-16-16-0
15-15-15-9	24-24-0-0	DAP Lite (16-44-0-0)
24-24-0-8	23-23-0-0	DAP 4S
DAP Lite-II (14-46-0-0)	MAP Lite (11-44-0-0)	13-33-0-6

Annexure 2 (b): Fertilizer Mixtures grades permitted in MP & Maharashtra

State	**N**	**P_2O_5**	**K_2O**	**State**	**N**	**P_2O_5**	**K_2O**
Madhya Pradesh	20	20	10	**Maharashtra**	10	20	20
	12	32	6		18	18	10
	12	32	16		20	20	0
	8	32	8		20	10	10
	20	20	0		5	10	5
	15	15	7.5		5	10	0

Source: Department of Fertilizers, MOCF.

Annexure 3: Fertilizer Mixture companies in MP & Maharashta

S.No	Maharashtra		
1.	BEC fertilizer company	12	Rama krishi rasayan Ltd
2.	Balaji Fertilizer company	13	Shri Bhavani Mishra fertilizer pvt Ltd
3.	Deccan Sales corporation	14	Sugarcane produces vividh karyakari sahakara society
4.	Lahari fertilizer and agriculture industries pvt Ltd	15	Shetkari sahakari tambakhu vikri sangh Ltd
5.	Basant agro tech Ltd	16	Sridatta fertilizer and chemicals Ltd
6.	Maharashtra agriculture industries corporation Ltd	17	Subash Fertilizer Pvt Ltd
7.	Maharashtra state cooperative marketing federation	18	Varad fertilizer & seeds P Ltd
8.	Maruti petrochem industries Ltd	19	Vardhaman coop marketing society
9.	Shiva global agro ind Ltd	20	Mahadhan Farm technologies pvt Ltd
10.	Parvati fertilizer Ltd	21	Vidarbha coop marketing society Ltd
11.	R.B.Patil kisan sahakari khedri vikri sangh Ltd	22	Misra fertilizer Ltd
	Madhya Pradesh		
1	Rama Phosphates Indore		

Source: www.tradeindia.com, www.indiacatalog.com & several other sources

Annexure 4: Refresher Courses for Extension officials of Agriculture Department

1. Refresher course on *Integrated Plant Nutrient Management System (IPNMS)*

Course content: Introduction of Integrated Plant Nutrient Management, Plant Nutrient Supply System in crops, Issues for effective adoption of Integrated Nutrient Management, Different organic and inorganic sources of Nutrients, Different practices of INM, Right to information, Bio-diversity & Integrated Pest Management

2. Refresher course on *organic farming practices and management*

Course content: Organic Farming, Introduction of organic farming & existing policies, Sources & Production of organic inputs, Methods of organic farming, Agronomical Practices & management in organic farming, Insect & Pest management through organic 13 sources, Standards & certification of organic produce, Value addition and marketing of organic produce, Right to information, Biodiversity & Farming System Approach (FSA) for Sustainable Agriculture Concept of Farming Systems.

3. Refresher course on *Horticultural crops Management*

Course content: Horticultural crops Management, Nursery management of vegetable crops, Intensification of drip irrigation in vegetable crops, Application water soluble fertilizer in vegetable crops, Advanced Protected cultivation of Horticultural crops, Packaging and marketing of vegetable crops, Processing and value addition of vegetable crops, Production technology for medicinal/ aromatic plants, Commercial propagation technology of fruit crops, Preservation technology of vegetable crops, INM & horticultural crops, IDM & horticultural crops, Seed production technology of fruits and vegetables, Inter cropping in fruit crops, Right to information, Biodiversity, Techniques for command area, Judicious use of water.

4. Refresher course on *Quality Control of Fertilizers*

Course content: Quality Control of Fertilizers, Regulatory provisions- acts & rules, Role & responsibilities of enforcement authorities, Registration of manufacturers, importers, dealers etc., Collection, Analysis of samples, reporting & actions to be taken, Regulatory provisions and quality control procedure for bio-fertilizers, Right to information.

Source: SIAET and VANAMATI

Annexure 5 : Training courses on soil health management-curriculum details

1. Model Training Course on *Sustainable conservation technologies for enhancing resource use efficiency in rain-fed farming* conducted by *CRIDA, Hyderabad*

Participants & duration: 20 Senior and middle level extension personnel of the rank of Joint Directors, Deputy Directors, Agricultural Officers and Assistant Agricultural Officers of the line departments for 8 days.

Curriculum: Observation of natural resources through management and strategies of rainwater management, crops & cropping systems, farm implements, soil health, intercropping systems, integrated farming systems, in situ moisture conservation technology, water harvesting and recycling, mulching practices in vegetable crops etc. Specific topics on use of polymers, tank silt application, site specific soil testing, application of decision support system for pest forecasting, use of Bio-chars, custom hiring services and agro-advisory services, increasing livelihood security of rural farmers livestock technologies like integrated farming systems modules, pasture management and exposure visits to Hayatnagar Research farm, Gunegal Research Farms and Fodder Research Station (Mamidipally).

2. Model Training Course on *Soil Quality Assessment in Semi-arid Tropics of Central India* organized by NBSS & LUP (ICAR)

Participants & duration: 20 Agriculture officers of the state Agriculture departments of different levels, extension, training and research officers for 8 days.

Curriculum: Importance of soil quality, variation aspects of soil quality, Assessing soil quality, determination of soil quality indices, Minimum datasets required for soil quality assessment, soil quality as a vital parameter for land quality, monitoring soil quality vis-à-vis climate change, Hands on exercise for soil quality assessment.

3. Winter school course on *Soil- Plant- Water Relations under Conservation Tillage Practices for Sustainable Agriculture* organized by IARI (sponsored by ICAR)

Participants & duration: Asst. Professors /Scientists or above in the National Agricultural Research System (NARS) for 21 days.

Course Content: Conservation tillage practice, Common standard and available equipments, Plant available water: New concepts and measurement methods, Soil compaction under zero tillage, Preferential flow under no/reduced tillage: Role of macro pores, Residue as mulch: Modification of soil water and thermal regime, Field and profile water balance under conservation agricultural practices, Nutrient management under no tillage condition, Modeling soil hydraulic properties and nutrient dynamics: Field scale simulation and distributed modeling with GIS, Soil aggregation and organic C under conservation tillage and residue retention, Modeling tillage effects on crop water use and yield, Framework for evaluating physical quality of tropical and sub-tropical soils, Optical, near-infrared and thermal remote sensing applications for crop growth

monitoring.	***contd..***
4. Summer school *on Recent Innovations for Improving Nutrient Use Efficiency through Integrated Nutrient Management in Major Field Crops* organized by IARI and sponsored by ICAR. **Participants & Duration: 25 researchers / teachers/ scientists in ICAR Institutes/ SAUs / Agricultural colleges in the rank of Scientists/ Asst. Prof. or above for 21 days.** **Course Content: Nutrient use efficiency, An overview, Integrated nutrient management: objectives, principles and practices for sustainable crop production, Agronomic bio-fortification of zinc and iron in major crops, Integrated nutrient management in cereal-based cropping systems, Soil health/quality and its management, Estimation of nutrient use-efficiencies viz., Partial factor productivity, agronomic use efficiency, recovery efficiency, physiological use efficiency, nutrient harvest index, nutrient mobilization index etc., Recent strategies for integrated nutrient management in rain-fed crops, INM and nutritional quality of farm produce.**	

Ref: Respective institutes

Annexure 6: Training courses organized by MANAGE on extension services and agri-business:

1. *ACBAC (Agri clinics and Agri business centers) training Module* organized by MANAGE

Participants & Duration: 25 Interested private individuals/entrepreneurs for 60 days with training cost Rs 35000 per person

Course content: I week-Orientation, Agro-ecological situation, farm mechanization, irrigation techniques, seed production technologies, seed testing, seed treatment, soil types, soil sampling, soil testing, soil testing based advisory, macro and micro nutrient deficiency, corrective measures, fertilizers, manures, bio-fertilizers (types, recommendations, time and method of application, problematic soils and their management, integrated nutrient management, organic farming, rain-fed farming and watershed management, II week- Important pests, causes, symptoms, plant protection measures, visit to farmers' fields, package of practices, post harvest technology, legal aspects, III week- Animal husbandry, fisheries, sericulture, visit to KVK/Agricultural university/college, organizing extension events, exhibitions, kisan melas, vegetable and fruit shows, IV week- Resources analysis, market survey, extension reforms, visit to kisan call centre, V to VIII weeks- Exposure visits (Agri-ventures), interaction on all the above subjects, Agri-business management, wrapping up.

2. *Post graduate diploma in Agriculture Extension Management* (PGDAEM)

Participants: the extension personnel from the districts

Duration and other details: one year spreading over two semesters with thirty-two credit load. In each semester, contact classes will be held at State training institute of Agriculture department/ an identified institute within the State. The program is conducted in distance learning mode supported by printed study material, contact classes, provision of e-content and assignment. The candidate is required to complete one assignment in each course in a semester. This training is organized by SAMETIs or identified institutes.

Course content: Introduction to Agricultural Extension Management (4 credits), Communication and Diffusion of Agricultural Innovations (3 Credits), Principles and Practices of Extension Management (3 credits), Participatory Approaches in Agricultural Extension (2 Credits), Research Methods in Agricultural Extension (2 Credits), Market led Extension (4 Credits), Basics of Market Led Extension, Policies and Act for Promotion of Agricultural Marketing, Agri-Business and Entrepreneurship Development (3 Credits), Project Management in Agricultural Extension (2 Credits), Information and Communication Technologies for Agricultural Development (3 Credits), Sustainable Livelihoods in Agriculture, Project work (3 Credits), any one of the above elective courses.

Contd….

3. *Diploma in Agricultural Extension Services for Input Dealers (DAESI)*

Participants: Input dealers with 10+2 academic qualification.

Duration and other details: One year in distance mode with classroom interactions and field visits on every Sunday (Market Holiday) for 48 Sundays approximately, supply of study material, using multi-media instructional devices with the help of experts in the field as resource persons

Course content: Agro-climatic conditions, soils analysis, land use planning, Integrated Nutrient Management (INM), Integrated Pest Management (IPM) and Crop Production Technology in respect of major crops including horticultural crops, vegetable crops, floriculture, Farm Mechanization, Business Principles, Business Ethics, General topics like National Integration, Privatization, Liberalization, Globalization, WTO regime etc, laws related to Agricultural Inputs, E.C. Act, Consumer Protection Act, Limitation Act, Civil Procedure Code (C.P.C.) and Criminal Procedure Code (Cr. P.C.) etc, Technical; Role of weather in Agriculture, Gaps in Production and schemes to overcome them, soil survey, land use planning , classification of soils, soil sampling analysis & interpretation of results, management of problematic soils, Rain-fed farming, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Crop Production Technology of important crops in the district, Farm Mechanization, Water Management, Irrigation System, Post – Harvest Technology, Extension Management ; Communication Skills, Negotiation Skills , New Dimensions in Agricultural Extension, FTCs, KVKs, ATMA, AC & ABCS, RMGs, Market Led Extension, Cyber Extension etc., Setting up of stall in an agricultural Exhibition/Kisan Mela , Individual Management; Orientation to Mediation for mind control, Business Development on Ethical Foundation, Globalization, Liberalization and Privatization , National Integration, Legal; Basics about Law, Seed Act, Seed Rules and Seed (Control) Order, Fertilizer (Control) Order, Insecticides Act, Insecticides Rules, Insecticides (Price: stocks display and submission of reports) Order, Other Related Acts, Consumer Protection Act, WALTA Act, Limitation Act and Act on Production and Distribution of Bio-Fertilizers, Besides Criminal Procedure Code, Civil Procedure Code .

Source: MANAGE