4. Agriculture: Growing of Cereals (including Rice), Leguminous Crops and Oilseeds

4.1 Definition of the Sector

The specific sub-sectors in agriculture sector used in this report for analysis are NIC codes 0111 and 0112 (see Table 4.1). Annexure 4.1 shows the state-wise yield of cereals, pulses, and oilseeds.

Table 4.1: Definition of the agricultural sub-sector used in the analysis

S.No.	*NIC 4–digit Code*	*Description*	*NIC 5–digit Code*	*Descriptions*
1.	0111	Growing of cereals (except rice), leguminous crops and oil seeds: This class includes all forms of growing of cereals, leguminous crops and oil seeds in open fields, including those considered organic farming and the growing of genetically modified crops. The growing of these crops is often combined within agricultural units. This includes growing of wheat, jowar, bajra, millets, other cereals, pulses (dal) and other leguminous crops such as peas and beans, not used as oilseeds, mustard oil seed, groundnut oil seed, sunflower oil seed, soya bean oil seed, other oil seeds	01111	Growing of wheat
			01112	Growing of jowar, bajra, and millets
			01113	Growing of other cereals
			01114	Growing of pulses (dal) and other leguminous crops such as peas and beans, not used as oilseeds
			0115	Growing of mustard oil seed
			01116	Growing of groundnut oil seed
			01117	Growing of sunflower oil seed
			01118	Growing of soya bean oil seed
			01119	Growing of other oil seeds
2.	0112	Growing of rice: This class includes the growing of rice, including organic farming and the growing of genetically modified rice.		

Source: Central Statistical Organisation, Ministry of Statistics and Programme Implementation. 2008. *National Industrial Classification (All Economic Activities)*. 2008. https://www.ncs.gov.in/Documents/NIC_Sector.pdf.

4.2 Value Chain

A value chain in agriculture identifies the set of actors and activities that bring a basic agricultural product from production in the field to final consumption, where at each stage value is added to the product. The various stages in the agricultural value chain and the usage of technologies in the various stages are explained below (Figure 4.1 and Table 4.2). Various stakeholders involve across the value chain are listed in Table 4.3.

- ***Crop Planning*:** The selection of a cropping plan is one of the initial stages in crop production at the farm level (Figure 4.1). The decision-making process

involves choosing which crops to cultivate, determining the acreage for each crop, and allocating them to specific plots, commodity price, and weather conditions.

Usage of Artificial Intelligence, Machine Learning, and use of Big data may help in improving yield (Table 4.2).

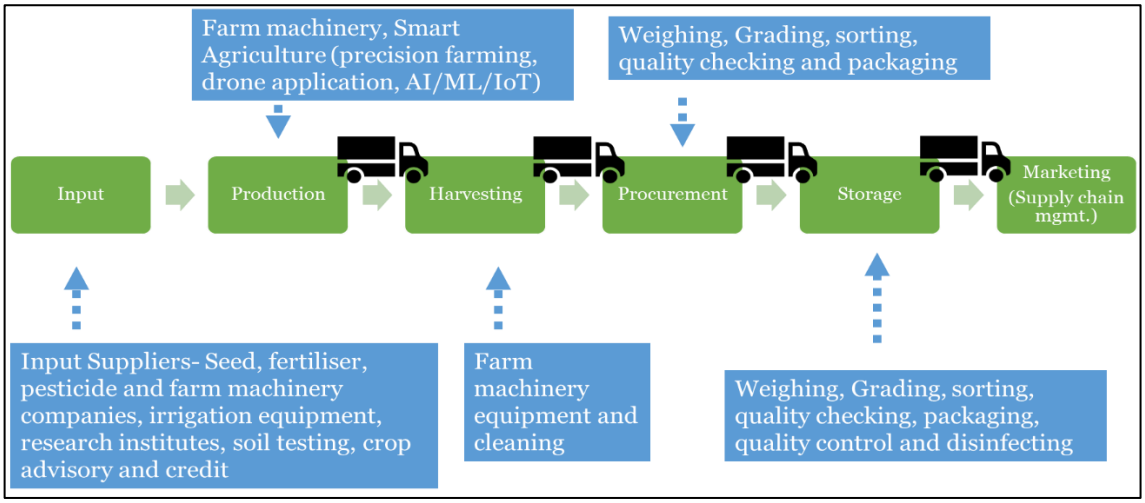
Skilling needs would arise for farmers, agri-startups, input suppliers, technical and extension personnel.

- ***Cultivation (Input & Production)*:** Cultivation deals with the preparation of fields for agriculture (Figure 4.1). This includes preparation of soil, access to credit, sowing of seeds, irrigation, and application of manure, pesticides, and fertilisers to the crops.

  Satellite and drone imagery are used alongside other internet of things (IoT) sensors to monitor crop health and soil conditions (Table 4.2). The data collected by these devices can be used to optimise irrigation schedules, predict weather patterns and digitize pest control. Modern tractors are highly automated and come with a range of features, such as GPS navigation, automated steering systems and hydraulic attachments, which increase efficiency.

  Skilling needs would arise for farmers, farm mechanics, farm machine operators, financial institutions which give credit to farmers like Primary Agricultural Cooperative Societies, extension personnel, input suppliers like Custom Hiring Centres (CHCs) and soil testing laboratories.

Figure 4.1: Agriculture value chain



Source: NCAER Conceptualisation from Literature.

- ***Harvesting*:** Once the crops are mature or fully ripe, they are cut and gathered (reaping), collectively called harvesting (Figure 4.1). Harvesting depends on factors such as season, crop variety, and maturity period. In recent times, machines called harvesters have been used for harvesting, especially in large-scale farming.

  Skilling needs would arise for farm machinery operators, crop harvesters, CHCs and farm machinery training centres. Female farmers need to be skilled so as to enable them to use farm machinery and agri-tech.

Sarkar (2020) and Aryal et al. (2021) show that the probability of ownership of farm machinery increases with education and/or training in agriculture[1].

- ***Supply Chain, Market, Quality*:** This covers post-production activities like processing, grading and sorting, storage, transportation, marketing, and commodity pricing. Procurement and storage are included in these processes (Figure 4.1).

  Supply chain technologies such as blockchain, big data analysis, and machine learning can help farmers, growers, and manufacturers track their produce from farm to table. Better supply chain management leads to greater efficiency in resource use, reduced waste, more accurate forecasting, and improved customer satisfaction.

  Skilling needs arise in processing, grading, and sorting stages. This can be done both manually and mechanically. This needs workers with the knowledge of shape, size, moisture content, etc. Storage needs workers in warehouses who check the quality of produce, fumigate produce to maintain its quality, etc. Even mandis need workers to track the arrival of produce, awareness of annual price trends, current and future market prices. These workers are setting the prices in the mandis. Skilled workers like loaders, packers working in mandis offer better packaging technologies, which reduce post-harvest wastage.

Table 4.2: Usage of technologies at various stages of agriculture value chain

S. No.	*Theme/Segment of agriculture value chain*	Value-added service innovative service	*Technologies to be used*
1.	Crop Planning	Micro and Macro Crop Planning	Artificial Intelligence (AI), Machine Learning (ML), Statistical Models, Soil data, Big Data, and Satellite Data
2.	Cultivation (Input & Production)	Smart Farming	Farm machinery, AI, ML, IoT, Drones, Satellite Data, and PoS
3.	Harvesting		Farm machinery
4.	Supply Chain	Logistics	Blockchain
5.	Market	Market Connect	AI, Satellite Data, and IoT
6.	Quality	Quality Testing & Traceability	IoT, Blockchain

Source: Adapted from Department of Agriculture, Cooperation and Farmer Welfare. 2021. Consultation Paper on IDEA: India Digital Eco-system of Agriculture.

[1] Sarkar, A. 2020. "Agricultural Mechanisation in India: A Study on the Ownership and Investment in Farm Machinery by Cultivator Households across Agro-ecological Regions". *Millenial Asia*11. (2): 160–186.

Aryal, J.P., Rahut, D.B., Thapa, G., and Simtowe, F. 2021. "Mechanisation of Small-Scale farms in South Asia: Empirical evidence derived from farm households survey". *Technology in Society* 65: 1–14.

Table 4.3: Stakeholders at various stages of value chain

Stage	Stakeholders
Crop Planning	Farmers, Krishi Vigyan Kendras, Agriculture Ministry at National and State Level, Indian Council of Agricultural Research (ICAR) Institutes and State Agricultural Universities, Soil Testing Labs, Seed Testing labs, Agri-tech Start-ups
Cultivation	Farmers, Seed companies/dealers; Fertiliser Companies/dealers; Farm Machinery companies/dealers; Irrigation Pump Manufacturers/dealers; Custom Hiring Centres, Credit Institutions, Farmer Producer Organisations (FPOs), Agri-tech Start-ups
Harvesting	Farmers, Custom hiring Centres, Farm machinery dealers/ operators, Farmer Producer Organisation, Agri-tech Start-ups
Storage and Transport	Warehouses/Cold Storage, Transporter, Farmer Producer Organisation, Agri-tech Start-ups
Marketing	APMC Mandis, Farmer Producer Organisations(FPOs), State Marketing Federations, Procurement Agencies, Farmer Producer Organisations, Agri-tech Start-ups

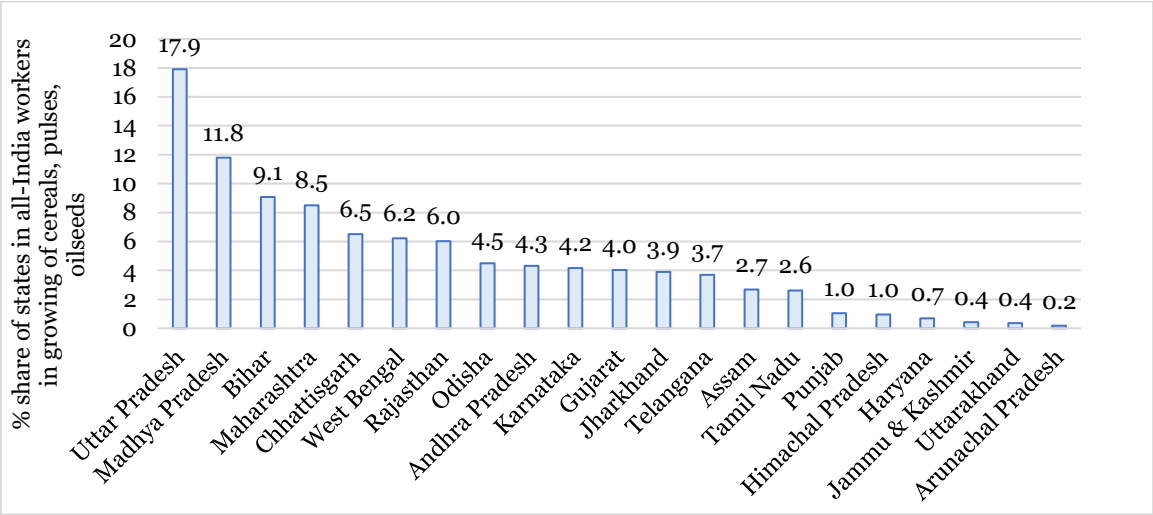
Source: NCAER conceptualisation.

4.3 Workforce Characteristics

The workers in this sub-sector are either low-skilled or low-medium skilled, concentrated in occupation. Nine states employ 75 per cent of the workers. Females form 41.4 per cent of the workers in this sector. They are low-skilled and 50 per cent of the workers are employed as helpers. Any skilling programme has to be designed keeping women in mind.

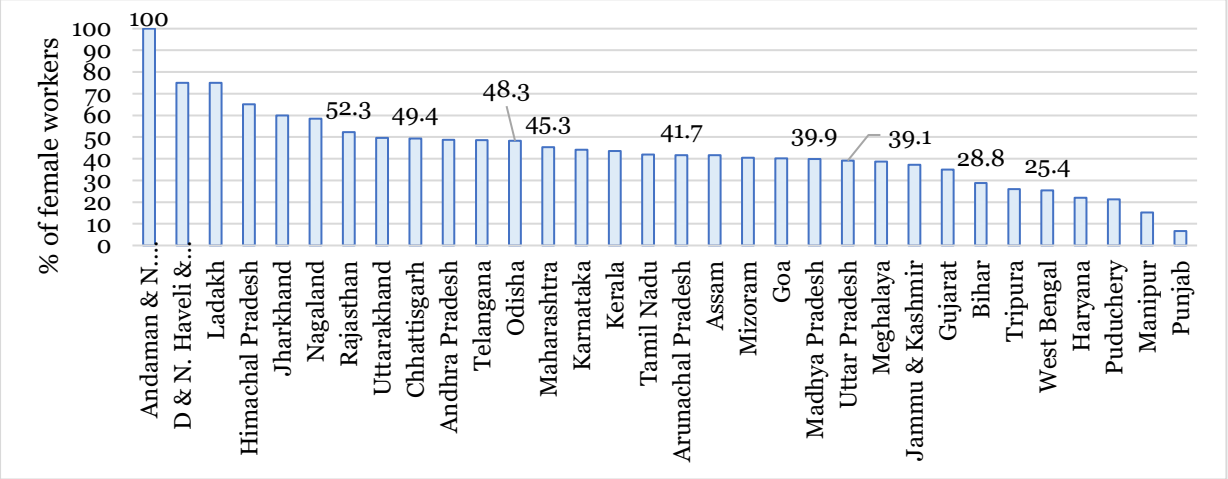
a. 41.4 per cent of workers engaged in growing of cereals (including rice), leguminous crops and oil seeds are females.
b. Across States: 75 per cent of the workers engaged in growing cereals (including rice), leguminous crops and oil seeds are concentrated in nine states namely Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Chhattisgarh, West Bengal, Rajasthan, Odisha, and Andhra Pradesh (Figure 4.2). Female workers at 52.4 per cent and West Bengal the lowest at 25.4 per cent (Figure 4.3).
c. Across Education: Overall 35 per cent of workers in the sector are not literate. The corresponding numbers for male workers are 25 per cent and females are 50 per cent (Figure 4.4). Almost all the workers have not received any technical education. 32.2 per cent of workers have received non-formal vocational education, mostly through hereditary means (Figure 4.5).

Figure 4.2: 75 per cent of the workers engaged in growing cereals (including rice), leguminous crops, and oil seeds are concentrated in 9 States namely Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Chhattisgarh, West Bengal, Rajasthan, Odisha and Andhra Pradesh



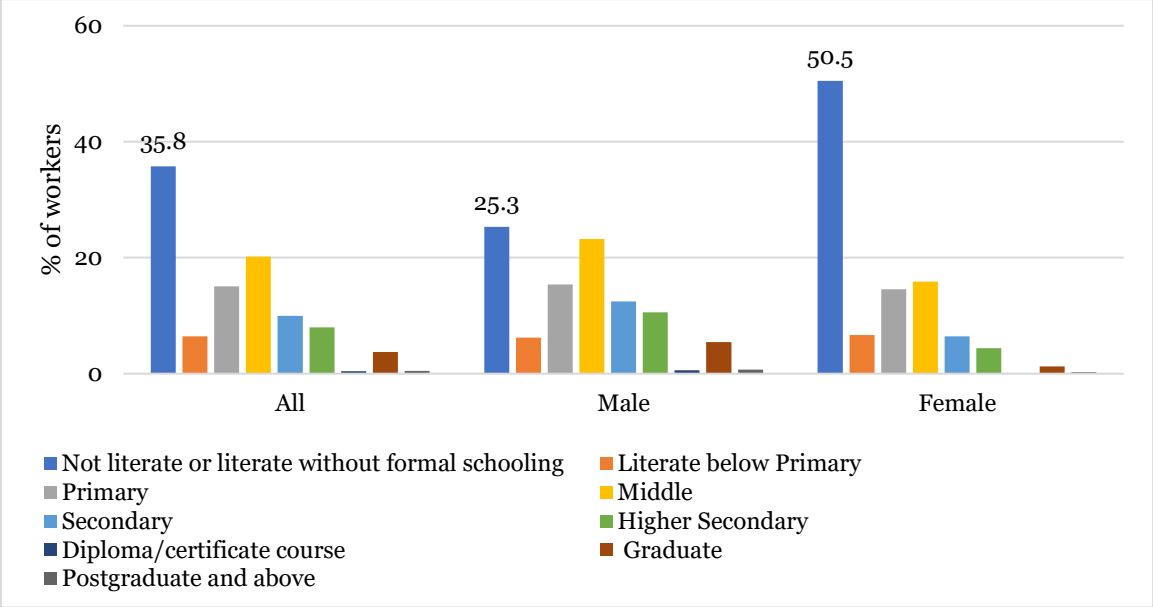
Source: NCAER computations from Ministry of Statistics and Programme Implementation, Government of India. 2023. Periodic Labour Force Survey (PLFS), July 2022-June 2023. Document No.: DDI-IND-CSO-PLFS-2022–23. https://microdata.gov.in/nada43/index.php/catalog/179/study-description. (PLFS 2022–23)

Figure 4.3: Percentage share of female workers (aged 15+) in growing cereals (including rice), leguminous crops, and oilseeds 2022–23



Source: NCAER analysis from PLFS 2022–23.

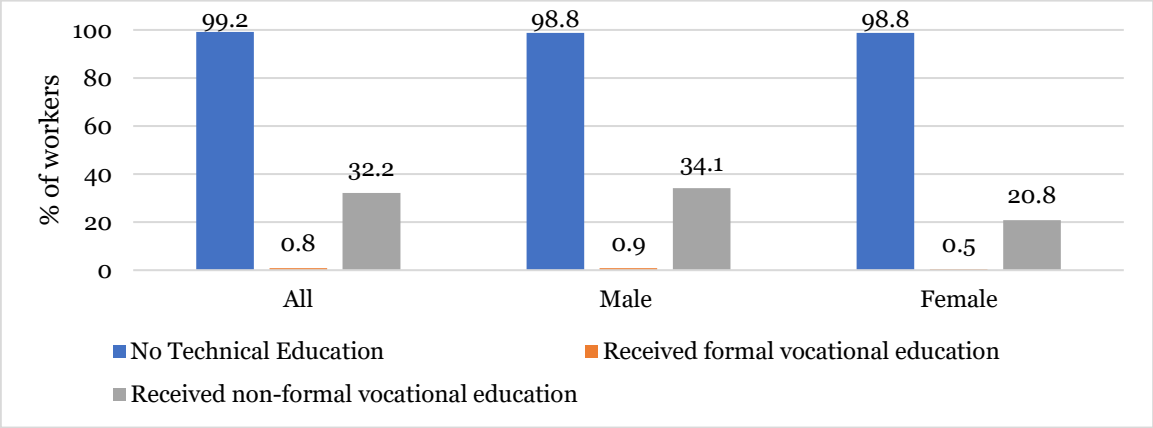
Figure 4.4: Percentage of agricultural (cereals including rice, leguminous crops, and oilseeds) workers by educational attainment, 2022–23



Source: NCAER analysis from PLFS 2022–23.

Note: Not Literature includes data from the following four categories - Not literate, Literate without formal schooling: EGS/ NFEC/ AEC, TLC and not literate_Others.

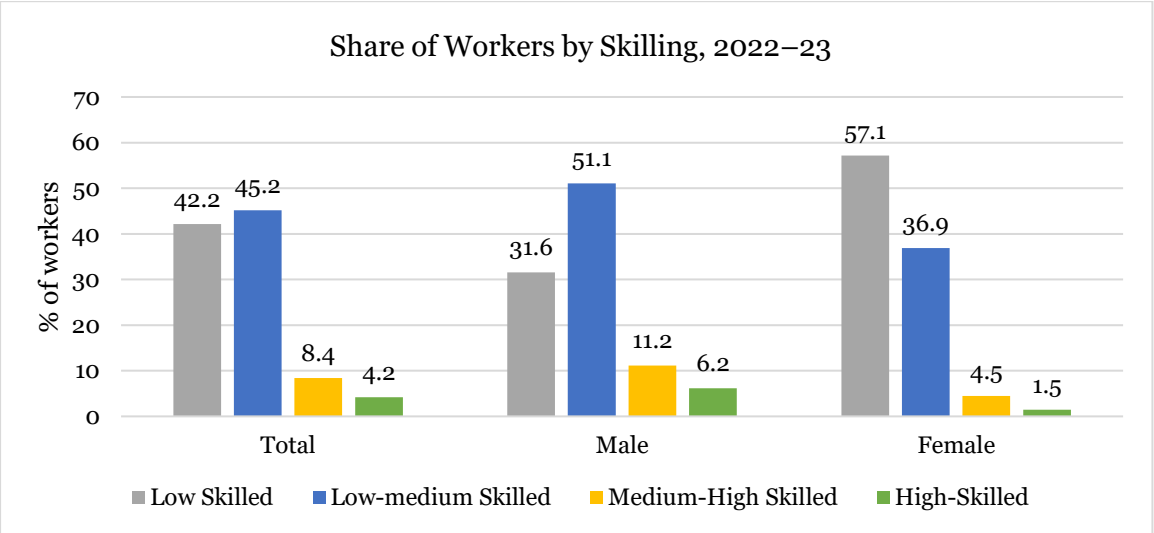
Figure 4.5: Percentage of agricultural (cereals including rice, leguminous crops, and oil seeds) workers (aged 15+) who have not received technical education and workers who have received vocational education 2022–23



Source: NCAER analysis from PLFS 2022–23.

d. ***Skills***: Majority of the workers are low-skilled or low-medium skilled (see Annexure 4.2 for definition of skills). However, majority of the female workers are low-skilled while male workers are low-medium skilled (Figure 4.6).

Figure 4.6: A large proportion of female workers in cereal (including rice), leguminous crops, and oil seeds growing workers are low-skilled whereas a larger proportion of male farmers are low-medium skilled

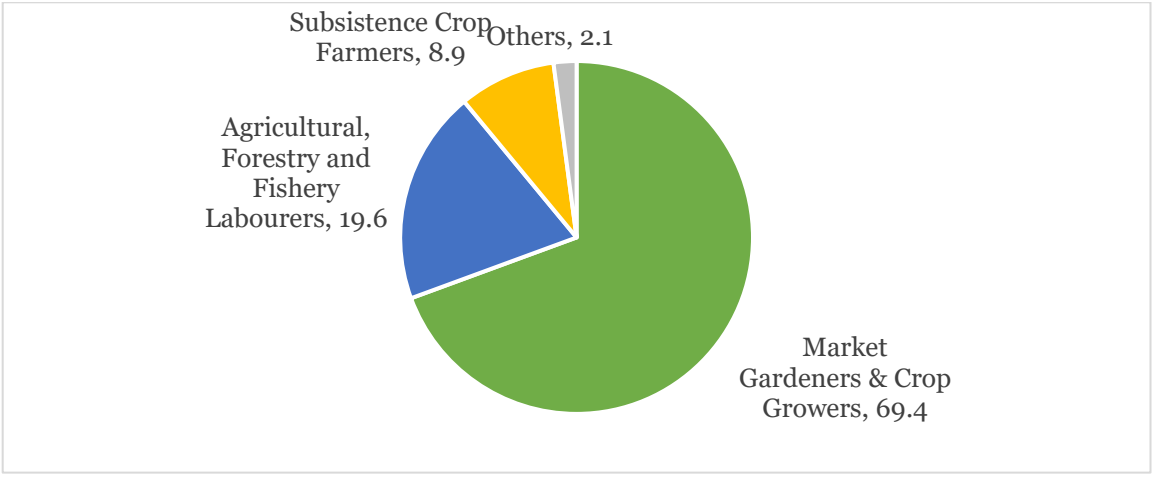


Source: NCAER computations from Ministry of Statistics and Programme Implementation, Government of India. 2023. Periodic Labour Force Survey (PLFS), July 2022-June 2023. Document No.: DDI-IND-CSO-PLFS-2022–23. https://microdata.gov.in/nada43/index.php/catalog/179/study-description.

Note: Check Annexure 4.2 for definition of skills.

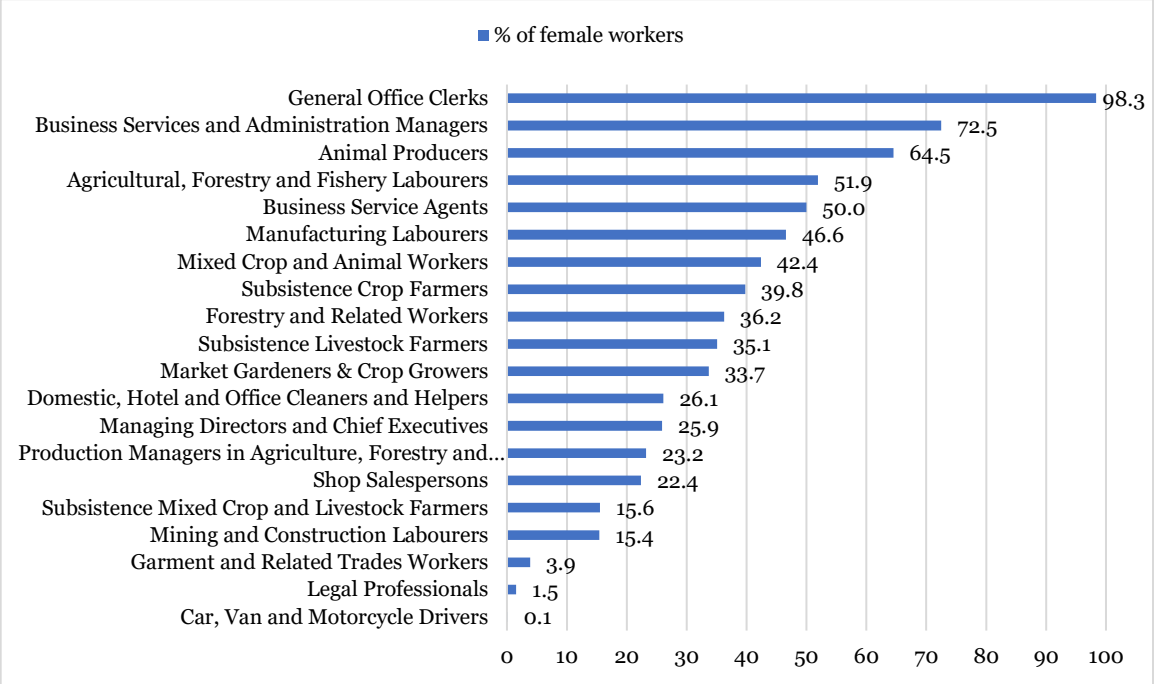
e. ***Occupations*:** Among the number of jobs, 70 per cent of the jobs are in the occupational role of market gardeners and crop growers and in that occupation 33.7 per cent were women (Figures 4.7 and 4.8). Twenty per cent of the workers in 'cereals (including rice), leguminous crops, and oil seeds' are agricultural, forestry and fishery labourers and within that 52 per cent are women. Nine per cent of the workers are subsistence crop farmers and within that 40 per cent are women. Figure 4.8 shows that there are some job roles dominated by women.

Figure 4.7: Majority (69.4 per cent) of the agricultural (cereals including rice, leguminous crops, and oilseeds) workers are market gardeners and crop growers, 2022–23



Source: NCAER analysis from PLFS 2022–23.

Figure 4.8: Percentage of female workers (aged 15+) across job roles in growing of cereals (including rice), leguminous crops and oilseeds, 2022–23



Source: NCAER analysis from PLFS 2022–23.

f. ***Engagement Status*:** Majority of the workers are self-employed. 39.5 per cent of workers are own-account workers (Table 4.4), 3.2 per cent are employers and 38.2 per cent are unpaid family workers. 19 per cent work as casual wage labour. 59.0 per cent of male workers are own-account workers, 5.0 per cent are employers and 20.8 per cent of workers are unpaid family workers. 15 per cent of workers work as casual wage labour. In case of females, 63 per cent are engaged as unpaid family workers. 11.8 per cent of females are own-account workers and 0.5 per cent work as entrepreneurs. 24.7 per cent of female workers work as casual wage workers.

Table 4.4: Engagement status (%) of agricultural (growing of cereals (including rice), leguminous crops and oilseeds) workers, 2022–23

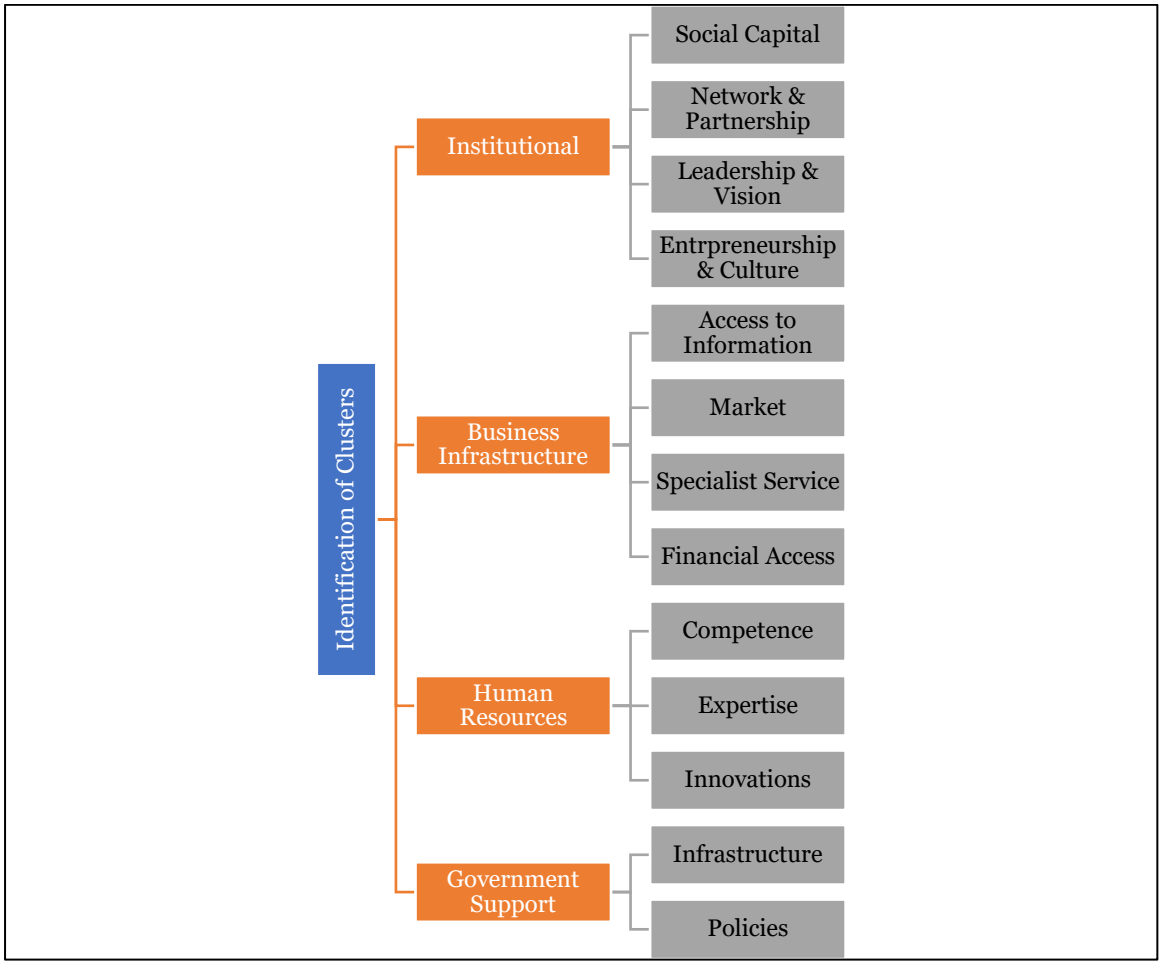
Sectors	All Workers (aged 15+)					
	Self-employed			Regular salaried/ wage employee	Casual Wage Labour	Total
	Own account worker	Employer	Worked as helper in h.h. enterprise (unpaid family worker)			
Growing of cereals (incl. rice), leguminous crops, and oil seeds	39.5	3.2	38.2	0.2	19.0	100.0
All workers 15+	35.6	3.2	18.6	21.4	21.2	100.0
All Male Workers (aged 15+)						
Growing of cereals (incl. rice), leguminous crops, and oil seeds	59.0	5.0	20.8	0.2	15.0	100.0
All workers 15+	39.6	4.5	9.5	24.0	22.3	100.0
All Female Workers (aged 15+)						
Growing of cereals (incl. rice), leguminous crops, and oil seeds	11.8	0.5	63.0	0.0	24.7	100.0
All workers 15+	27.3	0.6	37.4	15.9	18.8	100.0

Source: NCAER Analysis from PLFS 2022–23.

4.4 Geographical Clusters

There are many different definitions and different ways of estimating agricultural clusters (Annexure 4.3). The one that is used in this report is 'geographical clusters'. Geographical clusters in India arise due to specific agro-ecological conditions and resource availability. For instance, the Western Ghats region hosts geographical clusters of spice cultivation, including pepper, cardamom, and cinnamon, owing to its tropical climate and hilly terrain.

Figure 4.9: Framework to identify agricultural (growing of cereals (including rice), leguminous crops, and oilseeds) clusters



Source: Adapted from Sutawi, Prihartini I., Zalizar L., Wahyudi A., Hendraningsih L. 2022. "The Success Indicators of a Dairy Farming Cluster in Indonesia: A Case in Malang Regency of East Java Province". *Asian Journal of Dairy and Food Research*. 41(1): 22-27. doi: 10.18805/ajdfr.DR-242.

Delgado et al. (2014) defined clusters as "geographic concentrations of industries related by knowledge, skills, inputs, demand, and/or other linkages. This definition of clusters is used here in this chapter with the framework to identify geographical clusters being adapted from Sutawi et al. (2022).[2] The steps involved in defining an agriculture cluster are shown in Figure 4.9 and Annexure 4.4 shows the detailed methodology. A step-wise ranking approach is used to identify the clusters in this sector (Table 4.5).

[2] Delgado, M., Porter, M. E., & Stern, S. 2014. "Defining clusters of related industries". NBER Working Paper No. w20375. https://www.nber.org/system/files/working_papers/w20375/w20375.pdf. Boston: MA: National Bureau of Economic Research.

Sutawi, Prihartini I., Zalizar L., Wahyudi A., Hendraningsih L. 2022. "The Success Indicators of a Dairy Farming Cluster in Indonesia: A Case in Malang Regency of East Java Province". *Asian Journal of Dairy and Food Research*. 41(1): 22-27. doi: 10.18805/ajdfr.DR-242.

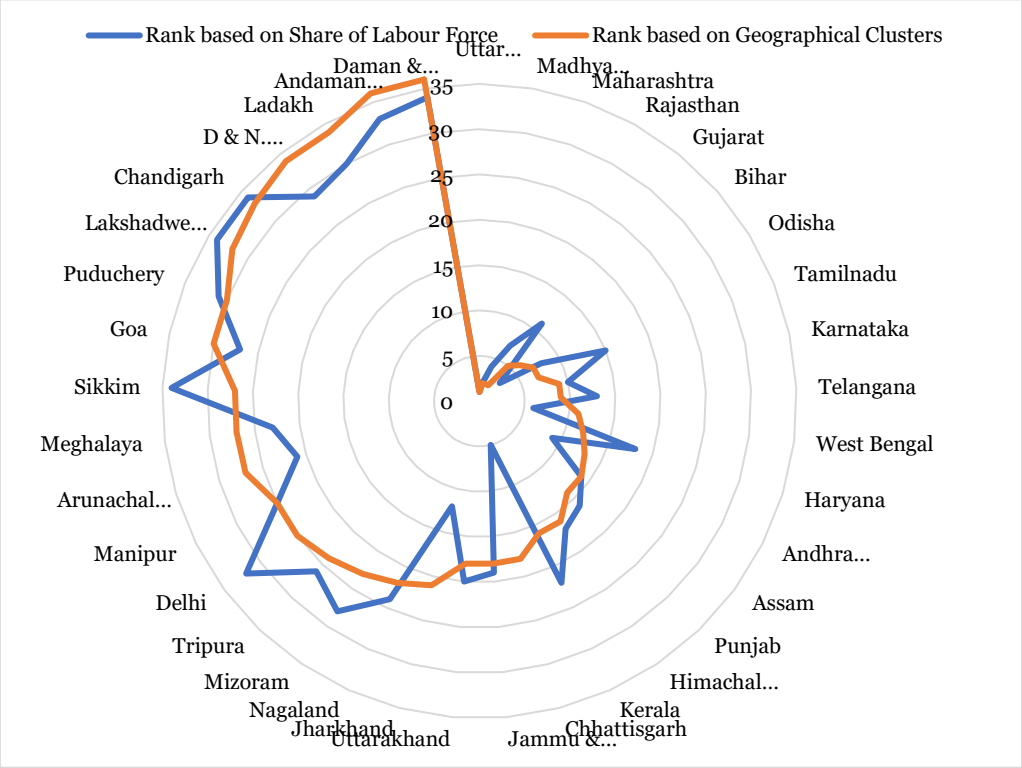
Table 4.5: Geographical clusters in agriculture (growing of cereals (including rice), leguminous crops and oilseeds)

State	*Institutional*	*Infrastructure*	*Government Support*	*Human Resource*	*Average of all the Rankings*
Uttar Pradesh	2	3	3	1	2
Maharashtra	1	2	14	2	5
Rajasthan	8	4	2	5	5
Madhya Pradesh	6	1	10	4	5
Gujarat	5	8	6	6	6
Bihar	10	13	4	3	8
Odisha	12	9	7	11	10
Tamil Nadu	9	7	5	20	10
Karnataka	7	10	12	14	11
Telangana	4	11	20	8	11
West Bengal	18	21	1	7	12
Haryana	14	6	21	10	13
Andhra Pradesh	11	5	23	15	14
Assam	23	20	8	9	15
Punjab	13	14	17	16	15
Kerala	3	19	19	21	16
Himachal Pradesh	21	16	11	17	16
Jammu & Kashmir	22	17	9	18	17
Chhattisgarh	20	12	24	13	17
Uttarakhand	17	15	18	19	17
Jharkhand	19	18	25	12	19
Nagaland	15	22	16	25	20
Mizoram	16	25	15	32	22
Tripura	26	23	13	30	23
Manipur	24	29	27	22	26
Delhi	25	24	30	24	26
Meghalaya	28	30	29	23	28
Arunachal Pradesh	31	32	22	28	28
Sikkim	27	28	32	26	28
Goa	29	31	28	27	29
Puducherry	30	26	31	29	29
Lakshadweep	32	27	34	36	32
Chandigarh	37	34	26	34	33
Dadra & Nagar Haveli	35	33	35	31	34
Ladakh	34			33	34
Daman & Diu	33	36			35
Andaman & Nicobar Islands	36	35	33	35	35

Source: NCAER Computations.

The rank-wise correlation of the states using share of workers employed in growing cereals, leguminous crops, and pulses (Figure 4.2) and the geographical clusters of these crops (Table 4.5) is 0.9. Figure 4.10 shows the rankings of the states using both the parameters. While the rankings overlap for many States, there are exceptions like Gujarat and West Bengal. While the share of workers employed in Gujarat is lower relative to its clusters ranking, West Bengal is the opposite.

Figure 4.10: Rankings using share of workers and geographical clusters for 'growing cereals (including rice), leguminous crops, and oilseeds'



Sources: NCAER computations from Table 4.5 and PLFS 2022–23.
Note: Lower ranking means higher concentrations.

4.5 Occupational Mapping

The PLFS publishes occupations at the 3-digit level. The corresponding 8-digit occupational codes from the National Classification of Occupations were identified based on the researchers' knowledge, literature review, etc. (wherever feasible). Further, they were mapped to the list of job roles in Agriculture Skill Council of India (ASCI) job roles, where they could be identified. Annexure 4.5 shows the list of occupations/job roles for the agricultural sector.

4.6 Stakeholders' Survey

4.6.1 Approach and Stakeholders Identification

As agriculture undergoes rapid transformation due to technology and market demands, targeted upskilling and reskilling initiatives are crucial for keeping farmers competitive and adopting modern practices. Skill assessment in agriculture is particularly challenging due to the complexity and diversity of the sector. Agriculture

is largely self-employed, with farmers managing their operations independently, leading to variations in skill sets. Diverse agro-climatic conditions require region-specific expertise, and the sector's vast array of activities—crop production, mechanisation, marketing, and sustainability practices—demand specialised knowledge.

Given the diversity within agriculture, it is more effective to assess skill needs at a granular level. Tailored assessments, focusing on specific regions, crops, or farming practices, provide a clearer picture of local requirements. In recognition of this, a district-level approach was adopted for this study, rather than a generalised, cluster-based analysis, to accurately identify skill gaps. Haryana, specifically the four districts of Haryana namely Faridabad, Gurugram, Hisar, and Karnal were selected for this study. All of them are key agricultural hubs, home to prestigious research and teaching institutions which provide a strong foundation for training in mechanisation, precision farming, and cutting-edge agricultural technologies. The districts combine traditional farming practices and increasing adoption of modern technologies makes it an ideal region for skill development interventions. The districts benefit from access to advanced seed and soil testing labs, agri-tech innovations, and its proximity to leading start-ups and Farmer Producer Organisations (FPOs), facilitating rapid skilling and technology transfer. Collaborations with these key institutions further strengthen efforts to address gaps in mechanisation, AI-driven farming, and market linkages.

Field visits were conducted in the above-mentioned districts, offering direct engagement with stakeholders across the value chain. These interactions provided valuable insights into the skill requirements for each stage—from crop planning to market access—highlighting the need for localised, tailored training programs. Table 4.6 shows the distribution of stakeholders and Table 4.7 shows who all NCAER interacted with at the district level against who were identified as stakeholders in the value chain. The questionnaire for agri-tech companies and farmer producer companies are attached (Questionnaires 1 and 2 respectively).

Table 4.6: Total number of stakeholders covered in the survey of 'growing of cereals, leguminous crops, and oilseeds'

Sector		***Number of stakeholders***
Ministry		1
Sector Skill Council		1
National-level Industry Association		1
No of Farms/Firms	Micro/Small	7
	Medium	5
	Large	3
	Total	15
No. of Placement Cells/TVET Institutions		5
Recruitment Agencies		Not Applicable
Other Stakeholders		9
Firms plus Other Stakeholders		24
Total		32

Source: NCAER.

Table 4.7: Stakeholders visited in Gurugram, Faridabad, Hisar, and Karnal

Stage	*Core Activities*	*Primary Stakeholders (√ indicates that these stakeholders were visited)*
Crop Planning	Determining crops, acreage, plot allocation, and weather conditions.	Farmers (√), Krishi Vigyan Kendras, Agriculture Ministry (National & State)(√), ICAR Institutes(√), State Agricultural Universities (√), Soil/Seed Testing Labs (√), Agri-tech Start-ups (√)
Cultivation	Soil preparation, credit access, sowing seeds, irrigation, applying fertilisers, pesticides, and manure.	Farmers(√), Seed/Fertiliser Companies & Dealers (√), Farm Machinery Providers(√), Irrigation Pump Manufacturers, Custom Hiring Centres (√), Credit Institutions, Agri-tech Start-ups (√)
Harvesting	Cutting, collecting, cleaning, sorting, and grading crops.	Farmers, Custom Hiring Centres (√), Farm Machinery Operators(√), Farmer Producer Organisations (FPOs) (√), Agri-tech Start-ups (√)
Storage & Transport	Grading, sorting, storing, and transporting produce.	Warehouses (√), Cold Storage Facilities, Transporters, FPOs(√), Agri-tech Start-ups (√)
Marketing	Developing and executing marketing strategies, and determining commodity pricing.	APMC Mandis (√), FPOs (√), State Marketing Federations(√), Procurement Agencies, Agri-tech Start-ups (√)

Source: NCAER.

4.6.2 Sectoral Findings about Skill Shortages and Skill Gaps from Stakeholders' Survey

The key relevant result that emerged from discussions was that there was no formal method to assess skill shortages in this sub-sector, but government targets served as a guiding metric. The NCAER approach was to systematically identify the stakeholders in the sector in the district and conduct interviews/FGDs with them.

There are challenges on the supply-side. There is a lack of industry readiness and entrepreneurial aptitude among agricultural university graduates, making it essential to strengthen practical training, improve industry internships, and implement robust skill evaluation mechanisms. Vocational training institutes face several challenges, including a lack of practical aptitude among students, limited exposure to emerging technologies, and difficulties with student placement. Many students show little enthusiasm for hands-on training, which undermines the practical application of their theoretical knowledge. Additionally, the current curriculum predominantly focuses on traditional trades, leaving students unprepared for industries like Renewable Energy (RE), digital applications, and drone technology.

On the demand-side, district-specific job roles may arise given the agro-climatic conditions in the district. Further, any job role in this sector needs to be given hands-on technical skills and entrepreneurship skills given the nature of the sector. These new, emerging and some old job roles will strengthen the agricultural ecosystem, improving efficiency, product quality, and market access for farmers. Because of the approach taken to examine the length and breadth of the eco-system, one sometimes ended up with job roles, which are not a direct fit in the agriculture but needs to be

included in the narrative to strengthen the eco-system. There are three key findings from stakeholders' survey about job roles:

1. Farmers and extension service providers need continuous re-skilling and upskilling. While agri-tech companies are providing knowledge and IT tools, farmers are not digitally literate/ready to utilise them to the fullest potential. Farmers' traditional knowledge needs to be upgraded with technical skills and entrepreneurship skills.[3]
2. New & Emerging Job Roles focussing in the 'sunrise' aspects of the sector: Some of the new job roles are:
    - Repair and maintenance of modern farm machinery especially brand-specific tractor skills.
    - Groundwater detection technologists: Groundwater detection technologists specialise in locating and assessing underground water sources. They use geophysical, geological, and hydrological methods to evaluate water availability and quality for agricultural, industrial, and domestic use. These are especially useful job roles in areas where ground level water is low like in the districts of Haryana. The required education is Diploma or Bachelor's Degree in Geology/Hydrology/Environmental Science. Technical skills required are use of groundwater detection equipment.
    - Farm mechanics need upskilling with knowledge of latest technologies such as Common Rail Direct Injection (CRDI) Tractor Engine Mechanics. A CRDI Tractor Engine Mechanic specialises in diagnosing, repairing, and maintaining Common Rail Direct Injection (CRDI) diesel engines used in tractors and other agricultural machinery. This role involves working with electronic fuel injection systems, sensors, actuators, and ECU (Electronic Control Unit) to ensure optimal engine performance, fuel efficiency, and emissions. Minimum Qualification required are ITI in Diesel Mechanic, Automobile Engineering, or Agricultural Machinery/Diploma in Mechanical Engineering or Automobile Engineering. Technical Skills required are familiarity with fuel injectors, sensors, actuators, and ECU operations.
    - Warehouse workers need technical and operational skills in grain handling, pest control, inventory management, and the use of modern technology for monitoring storage conditions. Key roles in warehouses, such as managers, quality control inspectors, procurement officers, and maintenance technicians, require expertise in logistics, safety standards, and quality assurance.
    - In FPOs, roles like General Manager, Marketing Manager, and Agricultural Extension Officer need to focus on leadership, procurement planning, quality control, and field operations to ensure smooth coordination and value addition for farmers.
    - Marketing Committees also require enhanced digital skills, market analysis, financial management, and stakeholder engagement to

[3] Sughanti, Sebastian and Sethi (2024) surveyed agri-tech start-ups and found that lack of skills adaptability was a major challenge for tech-adoption by farmers. This supports the findings from the NCAER stakeholders' survey too.

Sughanti, D., Sebastian, J. and Sethi, M. 2024. "Agri-Tech Startups and Innovations in Indian Agriculture". *RBI Bulletin*. Reserve Bank of India(RBI), Mumbai. November.

optimise auction processes and ensure compliance with regulatory standards.

- Community advisors are also job roles that may arise especially when it comes to advising farmers or communities about new farming techniques. The qualifications required for them are Agricultural Graduate/Diploma/ National Skills Qualification Framework (NSQF) Aligned Course.
- Agronomic Consultants deliver specialised technical expertise to enhance agricultural productivity and sustainability. They conduct comprehensive on-field assessments, analyzing factors like soil health, weather patterns, and crop performance to develop customized solutions. Their guidance covers areas such as crop rotation, pest and disease management, and the implementation of sustainable farming practices. Key competencies include advanced knowledge of agronomy, analytical skills, and proficiency in data-driven decision-making.

3. Job Roles which are deemed as difficult to fill: The top 5 job roles which are currently facing and will face a skills shortage over the next 3 years are presented in Table 4.8. Their qualification and skills requirements have been mapped.
    - Drone Operator is someone who knows how to operate drones.
    - Agriculture Advisor/Crop Advisor (Agri-tech): This is a job role that specifically arises in the Agri-tech sector. Agricultural Sales Advisors serve as vital links between input suppliers and farmers, offering tailored advice on crop management and the effective use of agricultural products such as seeds, fertilisers, and plant protection agents. They assess individual farm needs, recommend suitable products, and provide ongoing support to optimise product efficacy. A deep understanding of local farming practices, strong communication skills, and the ability to build lasting customer relationships are essential for success in this role.
    - IT-GIS Specialist (Agri-tech): Job roles in agri-tech sector which focus on using Geographic Information Systems to analyse data.
    - MIG-Welding Operator (Agro-tech): Job roles needed in agro-tech sector. Technically they are not in the agriculture sector.
    - Farm Machinery Service Technician: Job role that provides farm machinery services to farmers.

Table 4.8: Assessment of current and future skills shortage for top five job roles in "growing of cereals, leguminous crops, and oilseeds'

Items	*Drone operator*	*Agriculture advisor/Crop advisor (Agri-tech)*	*IT-GIS specialist (Agri-tech)*	*MIG-welding operator#*	*Farm -machinery service technician*
NCO 3/8-digit code	834	132	Not classified in NCO	821	723
NCO 8-digit / QP code	8341.0200 (AGR/Q1006)	1324.9900	DGT/2012	8212.1901	7233
Match from Job Projections in Chapter 3 (611, 921, 631, 613 and 633) @	No	No	No	No	No
No. of stakeholders which mentioned this (32)	6	14	3	8	9
Indicative computation of the extent of the need & vacancy rate (NCAER computations for 2026-27- Annexure 4.6)*	4,35,313 (if 25% net sown area is covered by drones)	-	-	-	5,56,510 (If 70% of farmers use farm machinery)
Geography (survey was done): Bottom-up approach in Haryana	Karnal, Kaithal, Hisar & Faridabad, Haryana	Gurugram, Haryana and Pune, Maharashtra	Hisar, Haryana	Karnal, Faridabad & Hisar, Haryana	Karnal, Faridabad & Hisar, Haryana
Average monthly income (₹)	₹30,000	₹20,000-₹ 30000	₹42,746	₹ 16,000-₹23,000	₹ 15,000
Educational Qualifications	ITI Graduate/Short-term Skilling Programmes like PMKVY	Agricultural Graduate	Graduate	ITI Graduate	ITI Graduate
Skills required at the competency level (3 and more)	**Cognitive:** Advanced reading skills, active listening, problem solving, communication skills, mathematical skills, digital skills, financial and resource management (entrepreneurial) **Socio-emotional:** Agreeable (entrepreneurial skills) **Technical & Vocational Education and Training Skills (TVET):** Understanding of remote sensing, data analysis techniques, actual drone operations, physical skills	**Cognitive:** Advanced reading skills, active listening, advanced digital skills, communication skills (including talking to farmers), business and local languages, problem-solving, judgement & decision-making, mathematical reasoning and science **Socio-emotional:** Skills needed for customer relationship (Agreeable, Extraversion), Conscientiousness (efficient), work independently in field settings, negotiation skills **TVET:** Agricultural knowledge, understanding of remote sensing, data analysis techniques,	**Cognitive:** Advanced reading skills, advanced digital skills, mathematical skills, mathematical reasoning, problem-solving, critical thinking, judgement & decision-making skills, communication skills and critical thinking **Socio-emotional:** Conscientiousness and agreeable **TVET:** Proficiency in Geographic Information Systems (GIS) software	**Cognitive:** Reading literacy, speaking, communication , time management **Socio-emotional:** Conscientiousness (resilience), Agreeable (team-work), openness to experiences and emotional stability **TVET:** Expertise in MIG welding techniques and safety protocols and Ability to read and interpret technical drawings and specifications Physical Skills	**Cognitive:** Reading literacy, numeracy, customer service skills – active listening, problem solving, communication skills, financial and resource management (entrepreneurial) **Socio-emotional:** Agreeable (entrepreneurial skills) **TVET:** Knowledge of mechanical systems and electronic controls in modern equipment, physical skills

Items	*Drone operator*	*Agriculture advisor/Crop advisor (Agri-tech)*	*IT-GIS specialist (Agri-tech)*	*MIG-welding operator#*	*Farm -machinery service technician*
		Precision Agriculture Techniques, Using AI, machine learning, and robotics, familiarity with blockchain for traceability and supply chain transparency			
Skills Shortage (as defined in Chapter 1)	Yes	Yes	Yes	Yes	Yes
Skills Gap (as defined in Chapter 1)	Not Applicable (NA)	Yes	NA	Yes	Yes
Relevance of TVET System	NA	Limited exposure to advanced agricultural technology Agricultural University graduates do not have the appropriate skills to work with farmers	NA	• Not taught in TVET • Practical, hands-on training missing • Shortage of master trainers	• Practical, hands-on training missing • Limited exposure to advanced agricultural machinery
Gender (Challenges)	NA	No issue	No issue	Not Aspirational for women because of physical skills required at job	Not Aspirational for women because of physical skills required at job
Challenges Faced by Industries in Meeting Skill Requirements	NA	• Multi-disciplinary knowledge about agriculture and IT is missing • Academia-industry collaboration limited • Lack of trainers	No issue	• MIG Welders not found • Skills shortage being addressed by in-migration • Apprentice ship system is a gap; needs to be strengthened	• Shortage of master trainers • Not enough TVETs • Inadequate training at Vocational Institutes with theoretical training emphasised; need training thereafter
Industry-specific interventions that facilitate skill & capacity development (best practices)	NA	No issue	No issue	Offered permanent jobs with written contracts of more than 1 year and social safety nets to attract workers	• Industry developing labs in both higher education and vocational training institutes
Policy Recommendations	**Skill Training Programme:** Need to be expanded, i.e., more programmes need to be introduced to train people as a Drone operator, thereby increasing supply; Strengthen the new training programme and ensure its spread all over the country	**Skill Training Programme:** Needs to be expanded **Curriculum Development:** Latest TVET skills, case studies, field studies with live practice on field, practical training courses in post-	**Skill Training Programme:** Needs to be expanded, Introduce new programmes in agricultural universities; dual degree programmes in IT and agriculture **Curriculum**	**Skill Training Programme:** Needs to be expanded; this should be introduced in the ITIs **Curriculum Development :** Arch and MIG welding need to be taught in ITIs **Gender:**	**Skill Training Programme:** Needs to be expanded, new programmes on upskilling and re-skilling on latest machinery **Curriculum Development:** Entrepreneurial skills should be

Items	*Drone operator*	*Agriculture advisor/Crop advisor (Agri-tech)*	*IT-GIS specialist (Agri-tech)*	*MIG-welding operator#*	*Farm -machinery service technician*
	Curriculum Development: Entrepreneurial skills should be taught along with TVET skills **Gender:** Drone-Didi programme has already started and this can be further strengthened by ensuring that the curriculum includes socio-emotional & entrepreneurial skills especially targeted for women. **Skill Initiatives:** Apprenticeships should be made mandatory.	harvest management, oral fluency in multiple (business plus local) languages and socio-emotional skills **Gender:** Strengthen socio-emotional skills and interaction with women farmers **Skill Initiatives:** Apprenticeships should be made mandatory; Encourage academia-industry collaboration.	**Development**: TVET skills **Gender:** Will be attractive to women **Skill Initiatives:** Repeated summer internships in programmes	Females can be encouraged for this job role **Skill Initiatives:** Local mismatches to be solved by increased coordination between industry and ITIs; Apprenticeships should be made mandatory for ITI students in welding.	taught along with TVET skills **Gender:** Females can be encouraged for this job role and special training programmes may be designed for women like 'Drone Didi' **Skill Initiatives:** Farm machinery companies should be providing training & certification and also offer re-skilling & upskilling courses. Take lessons from the auto sector.

Source: Findings from stakeholder consultations.
Notes: # MIG Welding Operator is a role that does not fall in the agriculture sector directly. However, lack of them affects the agro-tech sector which produces farm machinery.
@ Pink shade indicates no match between I-O quantitative top 5 occupation projections and survey-based top 5 occupation projections. Not matching makes sense as the I-O analysis, projects top 5 job occupations where most of the workers are there. However, in the survey, stakeholders were asked that in which job roles, i.e. they are trying to hire people but are not able to hire. Plus, technological changes have created new job roles.
*Computation methodology presented in Annexure 4.6.

4.7 Recommended Methodology

This sector requires a bottom-up strategy, i.e., given the diverse nature of the country, a district-wise approach is recommended.

- Secondary data analysis using available data needs to be carried out to ascertain needs that can arise in the region by using available statistics at the Central and State level.
  - –Ministry of Statistics and Programme Implementation: Several data are published by MoSPI including data on value of output, Situation Analysis of Farmers can inform about the districts.
  - Ministries' publications including the Agricultural Census, soil, water statistics, etc.
  - States own statistical publications
- FGD Stakeholder Interactions using qualitative techniques.
  - The value chain needs to be specified.
  - Identify the stakeholders along the value chain who are present in the district or nearby districts.
  - It is important to identify three things—reskilling/upskilling needs, job roles that face shortage and identify new/emerging job roles.
  - Conduct interviews/Focus Group Discussions (FGDs) with all stakeholders.

- Farms- Traditional and Modern: Conducting FGDs with both traditional and modern farmers provides qualitative insights into the challenges and opportunities within the agricultural sector. These discussions can reveal perceptions about technological adoption, training needs, and labour requirements.
- Firms with farming linkages present in the district: Engaging with agribusinesses and firms linked to farming activities helps understand the demand for specific skills, technological needs, and workforce expectations. This interaction can highlight gaps between current educational outputs and industry requirements.
- Annual stakeholder discussions with education and skill training institutes: Regular discussions with educational and training institutions ensure that curricula align with evolving market needs. These discussions can lead to the development of targeted training programs addressing identified skill gaps.
- Annual joint stakeholder consultations with farms at the district level: Such consultations can lead to community-specific strategies for skill development and employment generation.

The combination of quantitative and qualitative techniques will inform about skill shortages and gaps in this sector. It is important to identify the jobs which are likely to face skills gap and identify the 'missing' skills. This can also feed into the State requirements. This information should link to the district skill plans.

Beyond shortages, it's crucial to identify jobs where existing employees or candidates lack essential skills. This involves mapping current skill sets against job requirements to uncover discrepancies. Addressing these gaps may involve curriculum adjustments, professional development opportunities, or recruitment strategies focused on acquiring the missing skills. Such insights are helpful for State-level workforce development policies.

It is important to identify upskilling and re-skilling requirements especially digital and financial literacy skills. This involves analysing trends to determine which skills are becoming obsolete and which are emerging as critical. Developing programs to equip the workforce with these new skills ensures adaptability and competitiveness in a changing economic landscape. Recognition of prior learning combined with bridge training will especially help farmers.