Climate Change
Innovation
Programme

BASELINE REPORT FOR

mango *and* arhar

Adapting to
Climate Change
in Agriculture:
Climate Resilient
Agriculture
Practices

The views expressed in this report do not necessarily reflect the UK government's official policies.

Climate Change
Innovation
Programme

BASELINE REPORT FOR

mango *and* arhar

Adapting to
Climate Change
in Agriculture:
Climate Resilient
Agriculture
Practices

Abbreviations and Acronyms

ACT	Action on Climate Today
CAGR	Cumulative Annual Growth Rate
CPGD	Climate Proofing Growth and Development
DFID	Department for International Development
FGD	Focused Group Discussion
FPO	Farmers' Producer Organization
FYM	Farm Yard Manure
GHG	Green House Gas
ICT	Information & communication Technology
IITM	Indian Institute of Tropical Meteorology
IMD	India Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MIDH	Mission on Integrated Development of Horticulture
MT	Metric Ton
NABARD	National Bank for Agriculture and Rural Development
NFSM	National Food Security Mission
NHM	National Horticulture Mission
NMSA	National Mission for sustainable Agriculture
Qt	Quintal
RKVY	Rastriya Krishi Vikas Yojana
SAPCC	State Action Plan for Climate Change
SAU	State Agriculture University
SSP	Single Super Phosphate
VCA	Value Chain Assessment/Analysis

Table of Contents

List of Tables

List of Figures

Executive Summary

The project **"Adapting to Climate Change in Agriculture: Climate Resilient Agriculture Practices"** intends to strengthen the capacity of the Agriculture Department to design, pilot, adopt and disseminate climate resilient agriculture practices and value chains of Mango and Arhar through handholding support for design of value chains and training at various stakeholder levels both within the government and at the farmer level. The overall objective of this project is to support informed interventions along the value chain of Mango and Arhar, to build resilience to the likely adverse impacts of climate change. These interventions could be made by government; community-based organizations, private sector entities and other stakeholders for replication and/or scaling up. The measures are likely to enhance the value share of the small and marginal farmers and other vulnerable groups in the process.

Odisha's fluctuating weather conditions suggest that it is reeling under climatic chaos. For more than a decade now, the state has experienced contrasting extreme weather conditions: from heat waves to cyclones, from droughts to floods. They have not only become more frequent but have hit areas that were never considered vulnerable. As a result, Odisha's economy has suffered. Agriculture, which is considered as the state's backbone, has been hit worst due to such changes in the microclimate and natural calamities. The extreme weather or climate induced natural calamities occurring alone or in combination create agricultural instability in the state. The production and productivity of crops play crucial role in the growth of agriculture sector; which unfortunately faces risks and uncertainties like deficient rainfall, pests attack, non-availability of credit, price fluctuations, failure of farming method, etc. Major factors like natural shocks of floods, droughts, severe cyclone, etc. and price variations in agricultural products contributed significantly to the varying degrees of growth rates. Climate change has the potential to derail the current growth strategy and deepen poverty in the state. Continuing climate variation is predicted to alter the sectoral growth, including the ability of the poor to engage in farm and non-farm sector activities.

Considerable debate exists whether a value chain should be for a different climate resilient crop or crops that are resilient in the context of the state, their value chain needs to be strengthened. This study aims for the latter. As part of the process, a multi-criterion analysis was undertaken to prioritise the crops that are climate resilient in an earlier scoping study. In consultation with the state government, two climate resilient crops - mango and arhar have been selected for value chain analysis and development of climate resilient operational strategy in Odisha. Arhar is one of the

hardy, drought tolerant perennial *legume* crop with a wide range of rainfall tolerance. It has wide adaptability to different climates and can grow on a wide range of soils with tolerance to a wide range of pH. As a pulse crop, arhar has the ability to biologically fix nitrogen. It contains high levels of protein and important amino acids thus contributing to food security and combat malnutrition. A perennial crop like mango can stay alive under desiccating conditions and this capacity can be highly advantageous for yield in succeeding growth seasons. It can withstand dry weather and is moderately drought tolerant. It has the capability to grow in a wide range of vegetation zones and can enhance carbon sink. It is one of the most popular, nutritionally rich fruits with health promoting qualities.

This report assesses the baseline scenario of mango and arhar value-chains in Odisha. This report is followed by a detailed recommendation report for strengthening and climate-proofing the value chains.

For assessing the baseline scenario of mango and arhar value chains in Odisha, nine districts from eight different agro climatic zones having different degrees of vulnerabilities to climatic risks have been selected. For analysing baseline situation, participatory and consultative approach was followed involving different stakeholders at different operational levels. Study was conducted in the selected clusters by interacting with value chain players at different levels and at different stages of value chain. All the existing practices and processes were mapped to assess the current scenario. In order to understand the supply chain behaviour beyond the state boundary, interaction with the market players in the neighbouring states have also been undertaken. All the collected information/data were crosschecked/triangulated and analysed for interpretation and conclusion.

Current scenario at different stage of value chain as revealed from the study is analysed below.

Pre-production (soil, variety, nursery management etc.):

- Most mango growers are aware of soil testing and its implications. However, only 40% of them have done soil testing and among them 69.44% have adopted the recommendation. About 32% of the arhar growers have gone for soil testing and 75% of them have adopted soil test recommendation.
- 43.33% of mango growers are using High Yielding Variety and 34.44% preferred hybrid variety. Majority of the arhar growers (78%) are using local varieties where as 22% prefer High Yielding Varieties.
- Women members of the farm families/woman labour are engaged in seedling transplanting, watering and weeding in nurseries and for planting and watering in the mango orchards; and broadcasting/ sowing of arhar seeds.
- Farmers face climate risks like dry spell, wet spell, heat waves, hail storm, flood and cyclone during pre-production stage.

Production (cropping system, irrigation, fertilizer use, pesticide use, etc.):

- Majority of the mango growers (77.66%) adopted mono cropping system where as 22.34% grow other crops like pineapple, lemon and arhar as intercrop with mango. 48% the of arhar farmers are growing arhar as intercrop with cotton and ground nut, 42% of the farmers grow arhar in paddy bunds and 10% of the farmers are growing arhar as mono crop.
- 55.55% of mango growers are providing irrigation from different sources. Most of them (72%) depend on wells and tube wells followed by lift irrigation points (18%), canal water (8%) and tanks (2%). Arhar is mostly grown as rainfed crop. 88% farmers depend on rainfall and only 12% provide irrigation. Among them, 50% depends on well/ tube well, 33.33% on lift irrigation points and 16.66% on canal.
- Most mango growers (73.33%) are using farm yard manure, whereas only 4.44% of farmers are using vermicompost and 2.22% are applying green manure. 56.67% of

farmers are applying urea, 6.67% and 3.33% of farmers are applying SSP and potash respectively. 36% of arhar farmers apply urea, 12% apply SSP and 6% apply potash to the crop.

- 75.56% of the mango farmers are using chemical/inorganic pesticides and 6.67% of farmers are using organic pesticides where as 56% of arhar farmers are using chemical/inorganic pesticides and only 4% prefers organic pesticides
- Women members of the farm families/women labour are engaged in weeding, watering, harvesting/plucking and intercultural operations in mango field and in arhar field women are engaged for weeding, watering, harvesting, threshing and intercultural operations.
- Farmers face climate risks like dry spell, wet spell, heat waves, hail storm, flood and cyclone during production stage.

Processing (cleaning, sorting, grading, value addition, etc.):

- 10% of farmers are cleaning/washing the harvested mangoes, 5.56% of farmer are drying the mangoes in shade after washing. Only 4.4% prefers sorting and grading of mango before selling. Green mangoes are sold in the market/haat or sold to the local traders or used for pickle making by the house hold. Green mangoes are also kept for ripening through putting under straw/hay for a week and then sold in the market/haat or sold to the local trader.
- Processed products like mango pickles and dried mangoes are prepared by the house hold mostly for home consumption. Woman members of the farm families/ woman labour are engaged in cleaning/washing, sorting, grading of harvested mangoes, splitting, de stoning, drying of raw mangoes, pickle making, etc. Mango pickles, mango drink, dried mango, mango jam, etc. are prepared and sold in the market. Processing units procure green as well as ripe mangoes from different sources and places for preparing the processed products of mango.
- The harvested arhar grains are kept open for 2 to 3 days for drying and then cleaned by removing inert matters and debris if any. Woman members of the farm families make in house dry fry of the grains to de-husk and manually stone grinding to split the grain for making dal for home consumption. Some farmers depend on small dal mills for de-husking and splitting of the grains. Commercial processors are preparing processed arhar dal with polishing to increase marketability.

Marketing & consumption (place of sell, access to markets, consumer choice, etc.):

- 48.54% of the mango producers sell at farm gate, 22.33% sell at village haat/mandi, 3% sell at wholesale market, 18.45% sell at nearby towns while 3.88% sell beyond the district.
- Major portion of the produce (58.51%) flows from farmers to consumers through traders, wholesalers and retailers; 21.18% of the produce reaching consumers directly from the farmer, 17.04% produce flows through wholesalers and retailers to reach consumers from the farmers without an intermediate trader. Only 1.02% farmers sell their mango to the processors who are procuring it mainly for pickle making.
- Arhar is mostly grown for self consumption and not grown commercially. 79.01% of the arhar growers sell their produce at door step/farm gate, 15.11% at village hat and 5.88% at wholesale market. Major portion of the produce (66.71%) flows from farmers to consumers through small traders, big traders, processor, wholesalers and retailers. Rest 33.29% of the marketable arhar is sold to the consumers directly by the arhar growers. Woman members of the farm families are engaged in selling in the local market/haat.

- 55% of the mango consumers prefer to buy from local/retail shops while 25% buy from local market/mandi and 20% of the consumers depend on street vendors. While buying mango & its products, 40% of the consumers look for neat & cleanliness, 35% give emphasis to price while 25% give importance to quality of the product.
- 75% of the consumers prefer to buy arhar & arhar dal from local/retail shops and 15% buy from other sources like exhibition stalls, farmers, etc. 10% purchases from local markets and street vendors. 35% of the consumers give emphasis on price, 25% looks for quality and 25% give importance to neat & cleanliness. 10% of the consumers look for accurate weight while 5% are particular on proper packing of the product.

Opportunities exist for mango in demand for processed products, scope of export, willingness among farmers regarding commercial cultivation and favourable govt. policy. It has also constraints like uncertain weather, difficulty in accessing institutional finance, lack of organised market mechanism, lack of processing facility, etc. For arhar, opportunities exist in the demand for Arhar dal, scope for extension of area, suitable climate, favourable govt. policy, scope for export. Constraints include lack of suitable short duration high yielding variety, lack of interest among farmers, traditional cultivation, un-remunerative return, uncertainty in weather conditions and frequent occurrence of natural calamities, lack of institutional credit facility, lack of organised market mechanism, etc.

The opportunities and constraints highlighted through this study has been analysed in detail to come out with key recommendations for climate proofing and strengthening the value chains for mango and arhar in a follow-up report on **"Operational Strategy for Climate Resilient Value Chain Development of Mango & Arhar in Odisha"**. Some of the key recommendations from the follow-up study includes:

Short term-high impact priorities: Provision of high yielding climate resilient planting materials for mango and short duration high yielding varieties of climate resilient arhar seeds at block level during planting/sowing season, issue of soil health card to every farmer, provision of institutional credit facility, organising training programs for farmers, organising buyer-seller meet, mobile alert/message to the farmers on crop, weather and market information, organising training programs for women SHGs and woman members of the farm families on preparation of processed products of mango and arhar.

Long term high impact priorities: Establishment of aggregation centre, pack house at production cluster/block level, provision of small scale processing units at production cluster level, establishment of storage facilities, establishment of organised marketing mechanism for mango and arhar, contract farming/buy back arrangement, linkage of pulses producer groups/organization with Mid-day meal program and Aahaar yojana, establishment of marketing structure, mandi/hub for mango and arhar at production cluster/block level, crop demonstrations, organising exposure visits for farmers, establishment of weather forecasting unit at block level, promotion of micro irrigation system (drip irrigation) in mango orchards, promotion and strengthening of Farmer Producer Organizations for value chain development of mango and arhar in the state, establishment of soil testing laboratory at block level and provision of mobile soil testing services to farmers, promotion of farm mechanization to reduce dependency on human labour.

Other than these high impact recommendations there could be several short term-low impact priorities as well such as crop insurance provision for mango and arhar farming and provision of farm implements and equipment/ custom hiring centres at block level.

SECTION 1

Introduction

1.1 Brief about ACT (Action on Climate Today)

Action on Climate Today (ACT) works closely with governments (Afghanistan, India, Nepal and Pakistan) to develop strategies to combat the impact of climate change. ACT is working to reduce the effects of climate change in South Asia. The initiative is funded by the UK Department for International Development (DFID) and managed by Oxford Policy Management. It brings together two existing DFID programmes: Climate Proofing Growth and Development (CPGD) programme, and the Climate Change Innovation Programme (CCIP). ACT began in 2014 with the aim to help partner countries integrate climate change into their policies, plan and budgets. ACT provides active support in the following fields.

- Support the design and delivery of climate resilience.
- Promote investments for climate compatible development.
- Build the climate change knowledge of decision makers.
- Attract further climate change investment from the public and private sector.

1.2 Definition and Importance of Value Chain Analysis for Climate Proofing Growth and Development (CPGD)

Agri-value chain is the whole range of goods and services necessary for an agricultural product to move from the farm to the final consumer. Successful agricultural value chains are both productive and sustainable; they conserve the environment & natural resource base; adapt to climate change, price fluctuations & consumer needs. They improve people's lives and livelihoods and provide sustainable pathways to sufficient, nutritious & affordable food to meet the challenge of our growing population. Considerable debate

exists whether a value chain should be for a climate resilient crop or the crops that are resilient in the context of the state, their value chain need to be strengthened. In this case, two climate resilient crops arhar and mango have been prioritised through a multi-criteria analysis and their value chain is proposed to be strengthened.

A value chain approach supports integrated climate risk management through better connection of producers to markets and increased economic returns to small farmers. Thus, it is an approach not just for building climate resilience, but for providing more effective support for agriculture generally. A value chain approach recognises the interdependency of actors involved in all stages of a value chain – from production to consumption – and guards against climate change risks that threaten any part of this chain. It acknowledges that when it comes to responding to the impacts of climate change, it is impossible to provide effective support unless the whole value chain is taken into account.

The impact of climate change on agriculture value chain is far-reaching. It goes beyond reduced yields and crop losses caused by extreme weather events such as floods, droughts and hailstorms. More extensively, climate change-induced catastrophes – which are becoming ever more frequent – can lead to the destruction of processing and transport infrastructure and even supplies of seed for the next growing season. Thus, value chain analysis is extremely important for formulating strategy and action plan for Climate Proofing Growth and Development (CPGD) programme.

1.3 Landscape Analysis (VCA in Odisha)

Odisha is broadly divided in to 4 Physiographic zones namely, Coastal Plains, Central Tableland, Northern Plateau and Eastern Ghats. These are further subdivided into 10 agro climatic zones, viz., North-western plateau, North-central Plateau, North-Eastern coastal plain, East and South-Eastern coastal plain, North-Eastern Ghat, Eastern Ghat high land, South-Eastern Ghat, Western undulating zone, Western-Central table land and Mid-Central table land. Soil types range from fertile alluvial deltaic soils in coastal plains, mixed red and black soils in Central tableland, red and yellow soils with low fertility in Northern Plateau to red, black & brown forest soils in Eastern Ghat region. They differ widely from highly acidic to slightly alkaline and from light sandy to stiff clays[1]. The State has a cultivated area of 61.80 lakh ha comprising of 29.14 lakh ha (47%) high land,17.55 lakh ha (28%) medium land and 15.11 lakh ha (25%) low land.[2] Rice is the principal food crop in the state. Other cereals, pulses, oilseeds, sugarcane, vegetables, spices and fruit crops are also grown in the state.

1.3.1 Identification of gaps in existing policies and on-going programmes

National Agriculture Policy seeks to actualize vast untapped growth potential of Indian Agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro-business create employment in rural areas, secure a fair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalization. The Odisha state Agriculture policy gives impetus on irrigation to the farmer field, establishment of commercial agri-enterprise including preservation, processing, value added enterprise, dairy and fisheries unit by the unemployed youth agri-entrepreneur farmers. State agriculture policy emphasises on input management, soil health, research & education, agriculture extension, skill

1 www.agriodisha.nic.in
2 Odisha agriculture statistic 2013-14

development, watershed development, organic farming, integrated farming, post harvest management, agri-enterprises, processing, credit, risk management, agri-marketing, women in agriculture, application of information & communication technology (ICT) in agriculture.

For achieving the policy objectives, various programmes and schemes have been launched. For development of pulses and fruit crops in the state, various programmes are implemented under National Food Security Mission (NFSM-Pulses), National Mission for sustainable Agriculture (NMSA), Rastriya Krishi Vikas Yojana (RKVY), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and National Horticulture Mission (NHM) of Mission for Integrated Development of Horticulture (MIDH).

In spite of vibrant agriculture policy and programs in place, most of the farmers are not able to derive the benefits of the programs and schemes due to the following reasons,

- Shortage of designated human resources at grass root level and managerial level for successful implementation of various programs and schemes.
- Lack of suitable high yielding varieties of short-medium duration climate resilient seeds.
- Short & delayed supply of seeds and plant nutrients against the demand.
- Lack of market led crop planning leading to demand and supply gap.
- Inadequate marketing support mechanism.
- Inadequate support for value addition and processing (both primary and secondary).

1.4 Objective of the Study

The overall objective of this study is to support informed interventions along the value chain of Mango and Arhar, to build resilience to the likely adverse impacts of climate change. These interventions could be made by government; community-based organizations, private sector entities and other stakeholders for replication and/or involve scaling up and enhancing the value share of the small and marginal farmers and other vulnerable groups in the process.

wThe program intends to strengthen the capacity of the Agriculture Department to design, pilot, adopt and disseminate climate resilient agriculture practices and develop value chain of Mango and Arhar through extensive handholding support for design and training at various stakeholder levels both within the government and at the farmer level. Within the government the program intends to build capacity of the decision makers as well as the actual ground level implementers for thorough implementation of such practices in the future.

SECTION 2

Climate Change Impacts on Agriculture in State

2.1 Contribution of Agriculture to State Economy

Agriculture in Odisha is the mainstay of majority of the populace and thus, holds the key to socio-economic development of the State. It suffers from frequent natural calamities like cyclones, drought and flash floods. The growth in agriculture sector showed fluctuating trend during 2011-12 to 2016-17. During 2015-16, growth rate declined to 13.65%[3] due to severe drought in the state. During 2016-17, the growth rate improved significantly at 14.40% percent following a normal monsoon. During 2011-16, the average annual growth rate (CAGR percent) was 3.4 percent only. Although contribution of agriculture and allied sector is moving downward from 62% in 1950s to 19.91%[4] in 2016-17, still this sector continues to be the main employment provider to small and marginal workers. Growth of this sector is important not only for ensuring food security and reduction of poverty in rural areas, but also in sustaining growth of rest of the economy. The structural shift in the State economy of Odisha has been quite visible over a period of time. **The State economy has been experiencing a sectoral shift from agriculture towards industry and services sectors in recent decade.**

The production and productivity of crops play crucial role in the growth of agriculture sector. The sector faces risks and uncertainties like deficient rainfall, pests attack, non-availability of credit, price fluctuations, failure of farming method, etc. Major factors like natural shocks of floods, droughts, severe cyclone, etc. and price variations in agricultural products contributed significantly to the varying degrees of growth rates. Climate change has the potential to derail the current growth strategy and deepen poverty in Odisha. Continuing climate variation is predicted to alter the sectoral growth, including the ability of the poor to engage in farm and nonfarm sector activities. **The direct impacts of extreme climate-induced events could include loss of life, livelihoods, assets and infrastructure. All of these could affect the state's economic growth and nullify the effectiveness of macroeconomic policies and pro poor initiatives.**

3 Odisha economic survey 2016-17
4 Odisha economic survey 2016-17

2.2 Climate Variability over the State

Odisha's climate is tropical, characterized by high temperature, high humidity, medium to high rainfall and short and mild winters. Standing on the coastal belt, the weather in Odisha is greatly influenced by the sea. The tropical climate of the region is resulting in very high temperature in the months of April and May. On the contrary, the Eastern Ghats of the state experience an extremely cold climate.

There are three major seasons - Summer (March-June), Rainy Season (July-September) and the Winter (October-February). It is warm almost throughout the year in the Western districts of Sundergarh, Sambalpur, Baragarh, Bolangir, Kalahandi and Mayurbhanj with maximum temperature hovering between 40-46° C and in winter, it is intolerably cool. In the coastal districts, the climate is equable but highly humid and sticky. The summer maximum temperature ranges between 35-40° C and the low temperatures are usually between 12-14° C. Winter is not very severe except in some areas in Koraput and Phulbani where minimum temperature may drop to 3-4° C[5].

Actual rainfall received vary from district to district. About 84% of rainfall is received during the period from June to September[6]. Even though the quantum of rainfall is quite high, its distribution during the monsoon period is highly uneven and erratic. Flood, drought and cyclone visit regularly with varying intensity. The normal rainfall of the state is 1451.2 mm.[7] The month of July is the wettest and the major rivers may get flooded. The state also experiences small rainfall from the retreating monsoon in the months of October-November. January and February are dry. Rainfall patterns in Odisha have been more erratic since the 1960s, with below-normal rainfall across all districts being recorded for most years. **The normal 120 days of monsoon rain has shrunk to 60–70 days, and unusual spikes in rainfall, with torrential rainfall of over 200–250 mm/day[8], are more frequent during the monsoon, frequently resulting in floods. This situation has had a strong influence on agriculture, especially during rabi season, because of the reduced residual moisture.**

Odisha has a history of recurring natural disasters. While the coastal districts of Odisha are exposed to floods and cyclones, western Odisha is prone to acute droughts; a large section of the State is also prone to earthquakes. In addition, the State is also affected by disasters like heat waves, epidemics, forest fire, etc. The history of disasters substantiates the fact that about 80% of the State is prone to one or more forms of natural disasters.

2.3 Future Climate Projections

Climate model projections indicate that global average temperature will increase, with disproportionately higher temperatures in the tropics and at the poles. South Asia is especially vulnerable to climate change due to its high levels of population density, prevalent poverty and a high dependence on natural resources. Climate projections for India suggest that impacts are likely to be varied and heterogeneous, with some regions experiencing more intense rainfall and flood risks, while others will encounter less rainfall and prolonged droughts. **Among the more substantial effects is a projected spatial shift in the pattern of rainfall towards the already flood-prone coastal areas, while water-scarce regions become even more drought-prone and unproductive.** India will also suffer from higher tides, more intense storms fuelled by warmer oceans and further erosion along its coastline due to sea level rise. For India, climate variability and climate change pose huge risks to human life and threaten to endanger the sustainability of the country's economic growth. India's immense geographic diversity adds to the complexity of developing and

5 www.orissatourism.org
6 www.agriodisha.nic.in
7 www.agriodisha.nic.in
8 Odisha Climate Change Action Plan 2015-20

implementing an adaptation strategy. The impacts will vary across States, sectors, locations and populations.

The Odisha SAPCC 2018-2023 highlights the current and future vulnerabilities of Odisha under different scenarios based on scientific assessments. It also summarizes some major climatic events and their impacts as well as exposure to such events that likely to happen in future.

By 2100, the mean annual temperature globally is projected to increase by one to five degrees Celsius (24.5°C in 1970 to 28.5°C in 2080)[9], depending on the A2 scenario in IPCC AR5 and location. Coastal Odisha will remain relatively less warm than the rest of the state, even though it clearly breaches the 2°C barrier. North-western, western, and south-western Odisha show the highest rise in temperature. Southern Odisha will have less rainfall (-35mm to no change), the northwest and southwest would have higher annual rainfall ranging from +40mm to +72mm[10]. According to the IMD and IITM (Indian Institute of Tropical Meteorology), this may be due to the shifting trough line and the enhanced forest stock.

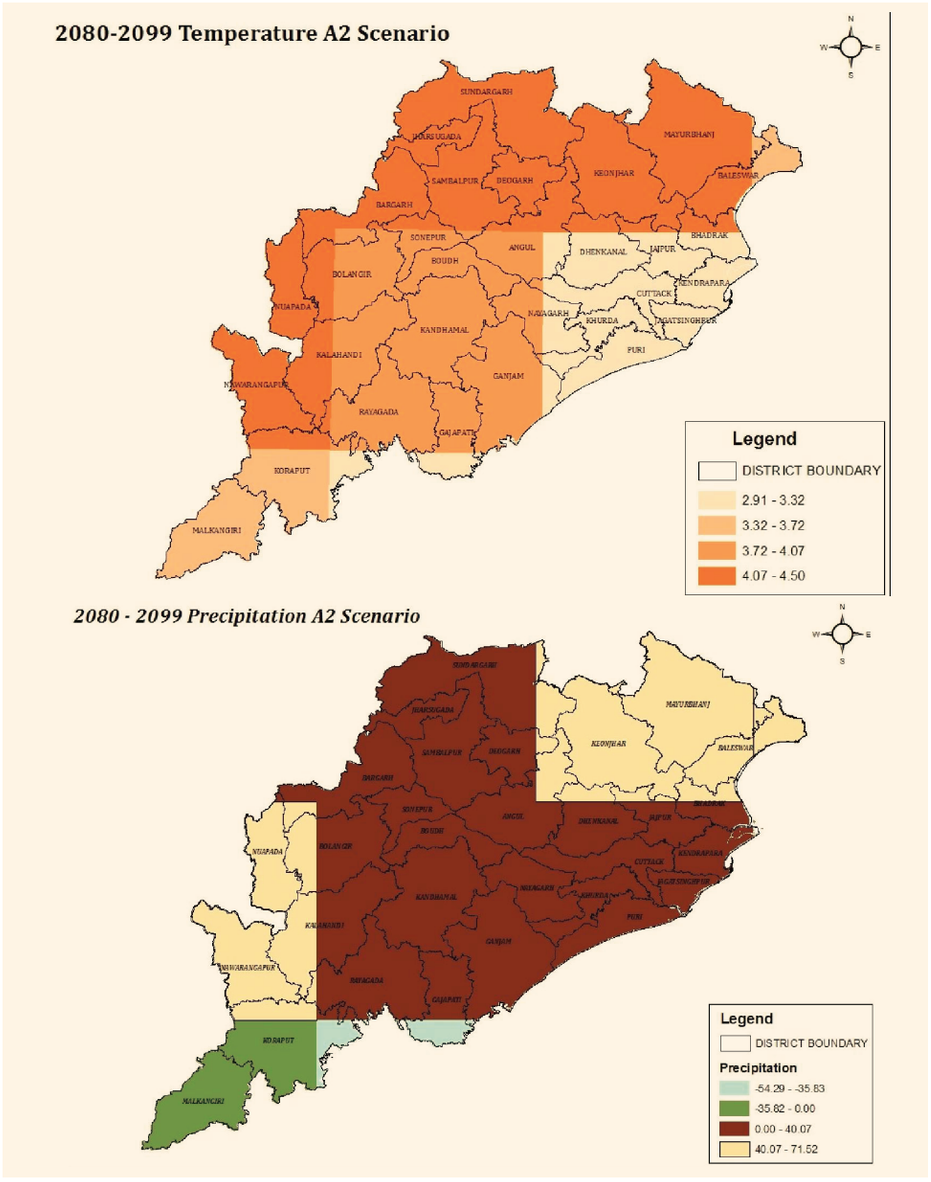


Figure 1: 2080-2099 Precipitation and Temperature A2 Scenario

9 Odisha Climate Change Action Plan 2015-20
10 Odisha Climate Change Action Plan 2015-20

Some of the future climate projections are[11];

- Late monsoon onset and more pre-monsoon rainfall.
- Reduced post monsoon and winter rainfall.
- Less rainfall in February, June and October.
- More number of cloudy days.
- Increased day and night temperatures in all the months except July.
- Maximum increase in temperature in post-monsoon followed by summer.
- Extended summer up to June.
- Increased number of hot, humid summer days in coastal areas.
- Warm and short winter with fewer cold nights in western Odisha.
- More frequent extreme weather events, such as hot extremes (maximum temperature above 45°C) and prolonged heat waves.
- More number of very heavy rainy days (>125 mm per day).
- Prolonged dry spell due to most rainfall over few days.
- More number of low-intensity low pressures at the Bay of Bengal.
- More intense tropical cyclones with larger peak wind speeds and heavier rainfall.
- Increased risk of drought and flood during monsoon.
- Intense storms resulting in loss of the rain water as direct runoff resulting in reduced groundwater recharging potential.

2.4 Impact of Climate Change on Crops

- The major agents of climate change has been ascribed to the increased levels of greenhouse gases (GHGs) beyond their natural limits due to the uncontrolled activities such as burning of fossil fuels, increased use of refrigerants, etc. Agriculture sector also contributes to climate change through emissions of GHGs during traditional farming practices as well as its expansion to non-agricultural land (e.g., forests). In view of these, the crops may encounter extreme weather events like drought, flood, heat and cold during its life cycle, resulting in substantial yield losses.
- Climate change impacts the crop yields both directly and indirectly. The direct effects are mainly due to change in crop duration and impacts reproductive processes such as pollination and fertilization. While the indirect effect are largely due to changes in water availability, altered pest, disease and weed dynamics. Rain fed crops are more vulnerable to climate change because of the limited options for coping with variability of rainfall and temperature. This will result in shift in sowing time and shorter growing season, which may necessitate effective adjustment in sowing and harvesting dates. Climate change has negative effects on irrigated crop yield due to temperature rise and changes in water availability, where as rainfed agriculture is primarily impacted due to rainfall variability and reduction in number of rainy days.

11 Climate Change and Agriculture in Orissa by Prof. SN Paupalak

Heat Stress: The continuous exposure of plants to high temperatures or heat stress during crop growth cycle is a major impediment to agricultural production and cause an array of morpho-anatomical, physiological and biochemical changes in plants, which affect plant growth and development eventually reducing economic yield. high temperature may slow down or totally inhibit germination. High temperature, in general adversely affects photosynthesis, respiration, water relations.

Cold Stress: Many plants, especially those, which are native to warm habitat, exhibit symptoms of injury when subjected to low non-freezing temperatures. Various symptoms in response to cold/chilling stress include reduction of leaf expansion, wilting, chlorosis and necrosis. In chilling stress, primary injury is the initial rapid response that causes a dysfunction in the plant, but is readily reversible if the temperature is raised to non-chilling conditions.

Salinity Stress: Salinity is a major environmental stress and is one of the chief constraints to crop production. Increased salinization of arable land is expected to have devastating effects on agricultural production in many countries including India. High salinity causes both hyper-ionic and hyper-osmotic stress and can lead to plant death.

Flooding and Submergence: Water logging which is also called as flood submergence, anoxia, hypoxia etc., is one of the major harmful abiotic stresses limiting crop yields. Generally, the flooding in the field can be either water logging in which root and some portion of the shoot under water are complete submergence where the whole plant is under water. Lack of oxygen supply for the plant is main cause of damage in water logging conditions, because of which plant shifts its metabolism from aerobic to anaerobic mode.

Hail Storm: The damages accrued with hails are determined by its characteristics that include the size and number of hailstones that fall per unit area and the strength of winds during a hail fall. The hail storm may damage the crops by heavy defoliation, shredding of leaf blades, breaking of branches and tender stems, lodging of plants, peeling of bark, stem lesions, cracking of fruits, flower and fruit drop.

Cyclone: Storm surges will inundate low lying areas of the coastal regions and destroy vegetation, reduce soil fertility, uproot trees & standing crops. Heavy & prolonged rains will cause river floods & submergence of low-lying areas.

SECTION 3:

Methodology

3.1 Prioritization Criteria (Site/Crop selection)

For preparing baseline report on mango and arhar value chain in odisha, nine districts of the state across different agro climatic zones have been covered to understand the existing scenario. Stakeholder consultations with the players in the value chain at different levels have been done to assess the prevailing situation. In order to understand the supply chain behaviour beyond the state boundary, interaction with the market players in the neighbouring states like Chhatisgarh, Jharkhand, Andhra Pradesh and West Bengal have also been undertaken.

Prioritization criteria for selection of districts and crops are described here under.

3.1.1 Choice of Climatic Vulnerable Agro Climatic Zones

The state is divided into ten agro climatic zones on the basis of soil, topography, rainfall, temperature, humidity and other agro climatic factors. The state experiences frequent occurrence of drought, flood, cyclone, heat waves and other climatic risks. About 80% of the State is prone to one or more forms of natural disasters/ climatic risks.

Different agro climatic zones and the districts falling under these zones with climatic characteristics are presented in the matrix below.

Table 1: Different agro climatic zones with climatic characteristics

Sl. No.	Agro-Climatic Zone	District	Climate	Mean Annual Rainfall (mm)	Mean Maximum Summer Temp(°C)	Mean Minimum Winter Temp(°C)	Broad Soil Groups
1	North Western Plateau	Sundargarh, parts of Deogarh, Sambalpur & Jharsuguda	Hot & moist sub-humid	1600	38.0	15.0	Red, Brown forest, Red & Yellow, Mixed Red & Black
2	North Central Plateau	Mayurbhanj, major parts of Keonjhar, (except Anandapur & Ghasipura block)	Hot & moist sub-humid	1534	36.6	11.1	Lateritic, Red & Yellow, Mixed Red & Black
3	North Eastern Coastal Plain	Balasore, Bhadrak, parts of Jajpur & Hatadihi block of Keonjhar.	Moist sub-humid	1568	36.0	14.8	Red, Lateritic, Deltaic alluvial, Coastal alluvial & Saline
4	East and South Eastern Coastal Plain	Kendrapara, Khurda, Jagatsinghpur, part of Cuttack, Puri, Nayagarh & part of Ganjam	Hot & humid	1577	39.0	11.5	Saline, Lateritic, Alluvial, Red & Mixed red & Black
5	North Eastern Ghat	Phulbani, Rayagada, Gajapati, part of Ganjam & small patches of Koraput	Hot & moist, sub-humid	1597	37.0	10.4	Brown forest, Lateritic Alluvial, Red, Mixed Red & Black
6	Eastern Ghat High Land	Major parts of Koraput, Nawarangpur	Warm & humid	1522	34.1	7.5	Red, Mixed Red & Black, Mixed Red & Yellow
7	South Eastern Ghat	Malkangiri & part of Koraput.	Warm & humid	1710	34.1	13.2	Red, Lateritic, Black
8	Western Undulating Zone	Kalahandi & Nuapada	Hot & moist sub-humid	1352	37.8	11.9	Red, Mixed Red & Black and Black
9	Western Central Table Land	Bargarh, Bolangir, Boudh, Sonepur, parts of Sambalpur & Jharsuguda	Hot & moist sub-humid	1614	40.0	12.4	Red & Yellow, Red & Black, Black, Brown forest, Lateritic
10	Mid Central Table Land	Angul, Dhenkanal, parts of Cuttack & Jajpur	Hot & moist sub-humid	1421	38.7	14.0	Alluvial, Red, Lateritic, Mixed Red & Black

Source: Odisha Agricultural Statistics

For assessing the value chain behaviour of mango and arhar in Odisha, nine districts from eight different agro climatic zones having different degrees of vulnerabilities to flood, drought, cyclone and earth quake have been selected.

The details of the selected sample districts are presented in the matrix here under.

Table 2: Sample districts with climatic vulnerability

Sl. No	Study District	Agro climatic zone	Climatic vulnerability			
			Wind & Cyclone	Flood	Drought	Earthquake
1	Ganjam	East and South Eastern Coastal Plain	1, 2	1, 2	3	2, 3
2	Mayurbhanj	North Central Plateau	1, 2	2	3	1, 2, 3
3	Sundargarh	North Western Plateau	3, 4	2	1	1, 2
4	Angul	Mid Central Table Land	3	2	2	1, 2
5	Balasore	North Eastern Coastal Plain	1	1	3	1, 2
6	Kalahandi	Western Undulating Zone	3, 4	2	1	3
7	Bolangir	Western Central Table Land	3	2	1	3
8	Dhenkanal	Mid Central Table Land	1, 3	2	2	1, 2
9	Rayagada	North Eastern Ghat	2, 4	2	2	3

Source: Odisha State Disaster Management Authority (OSDMA) for climatic vulnerability

Wind & Cyclone: 1 = Very High Risk Zone, 2 = High Risk Zone, 3 = Moderate Risk Zone, 4 = Slight Risk Zone

Flood: 1 = Liable to get flooded, 2 = Protected areas

Drought: 1 = Very High Risk Zone, 2 = High Risk Zone, 3 = Slight Risk Zone

Earthquake: 1 = Moderate Damage Zone, 2 = Less Damage Zone, 3 = Very Low Damage Zone)

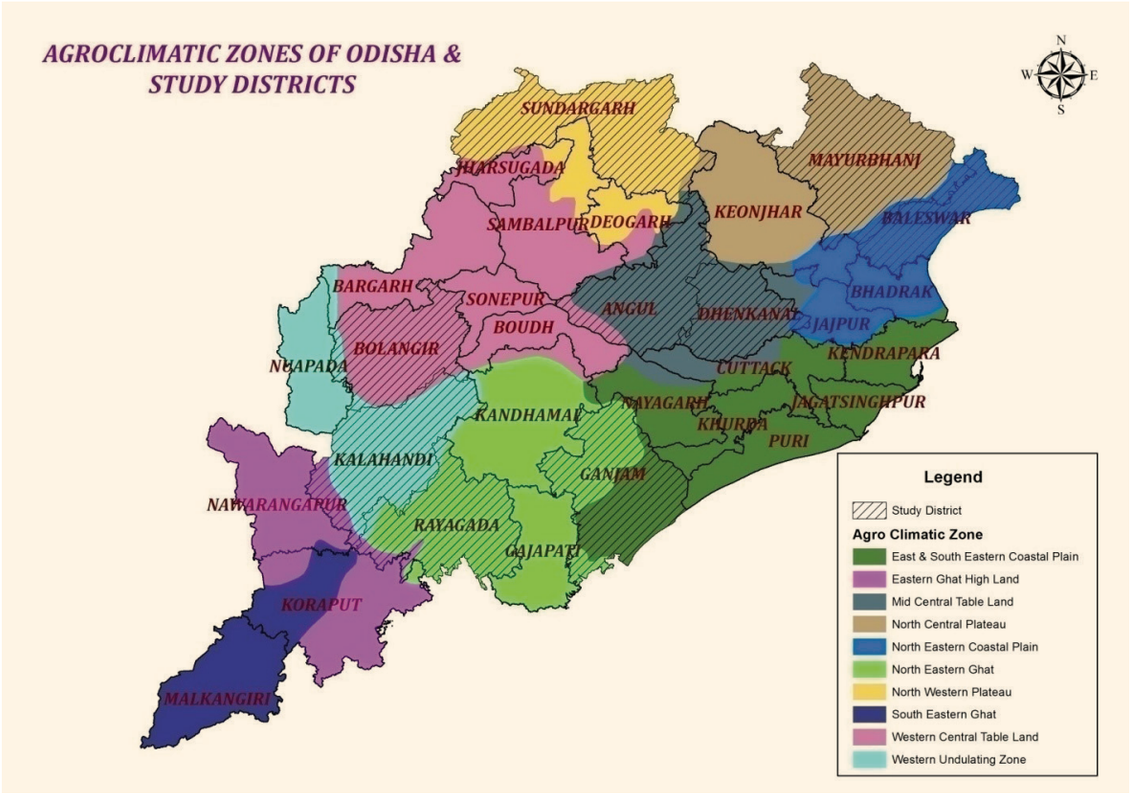


Figure 2: Agro climatic Zones of Odisha and Study districts

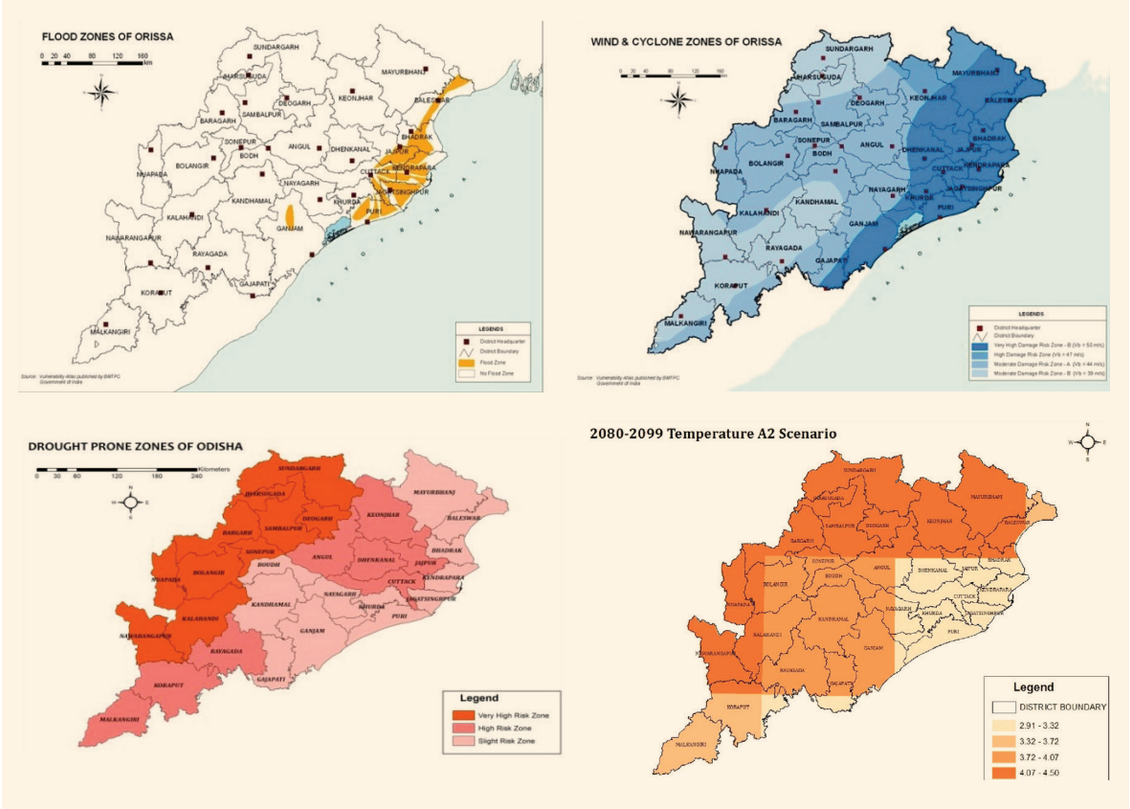


Figure 3: Vulnerability Maps of Odisha

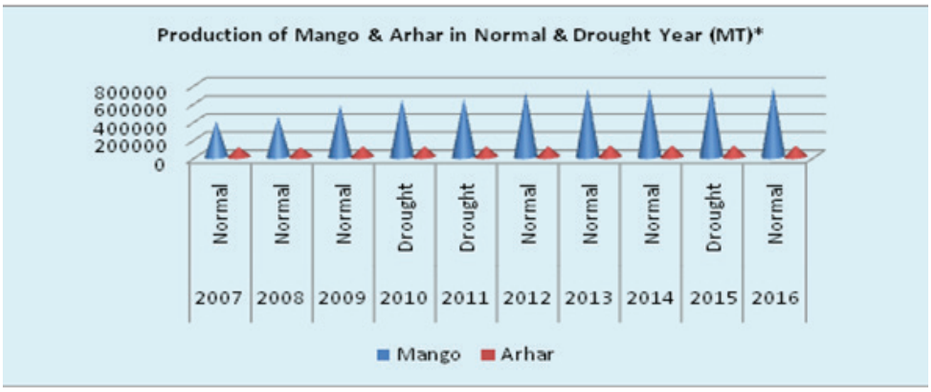
3.1.2 Selection of Climate Resilient Crops

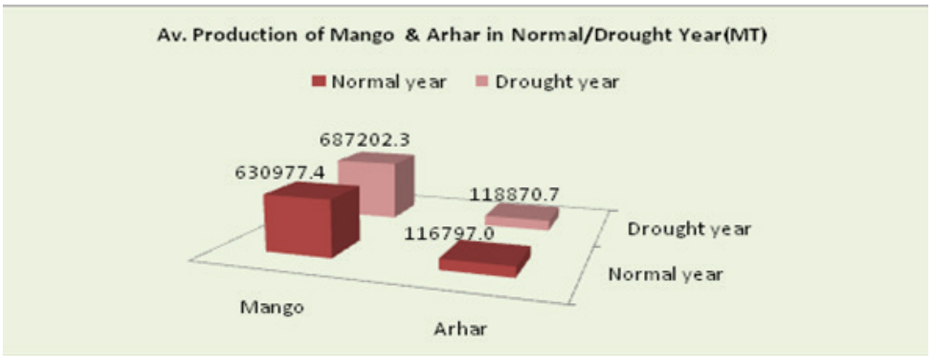
Two climate resilient crops- Mango and Arhar have been selected for value chain analysis and development of ideal climate resilient operational strategy in Odisha.

Arhar (Pigeon pea) is one of the hardy, drought tolerant perennial *legume* crop with a wide range of rainfall tolerance. It has wide adaptability to different climates and can grow on a wide range of soils, from sands to heavy black clays with tolerance to a wide range of pH. Arhar as a pulse crop has the ability to biologically fix nitrogen, in symbiosis with certain types of bacteria (e.g. Rhizobium, Bradyrhizobium). These bacteria are able to convert atmospheric nitrogen into nitrogen compounds to the tune of 72 to 350 kg of nitrogen per ha per year. As arhar fix nitrogen in the soil, it needs less fertilizers (organic and synthetic), and in this way, plays a part in reducing greenhouse gas emissions. The inclusion of arhar in crop rotation exploits symbiotic microbes to fix nitrogen, which is partly transferred to subsequent crops, increasing their yields. Intercropping or crop rotation with arhar has a higher soil carbon sequestration potential than mono crop systems. It also reduces the risks of soil erosion and depletion. Arhar contains high levels of protein and important amino acids thus contributing to food security and combat malnutrition.

Mango, being a perennial fruit crop, can respond to increases in temperature differently as compared to annual crops. It can withstand a wide range of temperatures from 0°C to 48°C, without being adversely affected. A perennial crop like mango can stay alive under desiccating conditions and this capacity can be highly advantageous for yield in succeeding growth seasons. It is a day neutral plant whose flowering is unaffected by photoperiod. It can withstand dry weather and is moderately drought tolerant. It has the capability to grow in a wide range of vegetation zones viz., sub-tropical humid, tropical desert, tropical dry, tropical moist deciduous, tropical mountain system, tropical rainforest and tropical shrub land. Mango tree can enhance carbon sink through carbon

sequestration. Various studies show above ground carbon stock density was 3-4 tonnes/ha, while the soil organic carbon was 28-30 tonne/ha. Colloquially known as “The king of the fruits”, mango is one of the most popular, nutritionally rich fruits with unique flavour, fragrance, taste, and heath promoting qualities. It is rich in pre-biotic dietary fibre, vitamins, minerals, and poly-phenolic flavonoid antioxidant compounds. It is an excellent source of Vitamin-A and flavonoids like β-carotene, α-carotene, and β-cryptoxanthin.





3.2 Value Chain Analysis (VCA)

Value chain analysis is a useful analytical tool that helps understand overall trends and identify change agents and leverage points for policy and technical interventions. It identifies chain actors at each stage and discerning their functions, relationships and analyzes the factors influencing performance. It evaluates each stage in order to detect problems/ constraints or identify opportunities to improve the contribution of specific actors and the overall performance of the chain.

Production Analysis of Mango & Arhar in Normal Vs .Drought year

- Average production of both Mango & Arhar in drought year exceed the average production in normal year.
- Average production of Mango is 630977.4MT in normal year & 687202.3MT in drought year.
- Average production of Arhar is 116797MT in normal year & 118870.7MT in drought year.
- This signifies that, Both Mango & Arhar are drought tolerant and climate resilient crops.

** Source: agriodisha.nic.in*

The overall methodology comprises of observational design covering interview with different stakeholders and physical observation of different infrastructural and service facilities. The methodology also encompasses collection of both primary and secondary data from different sources and its analysis.

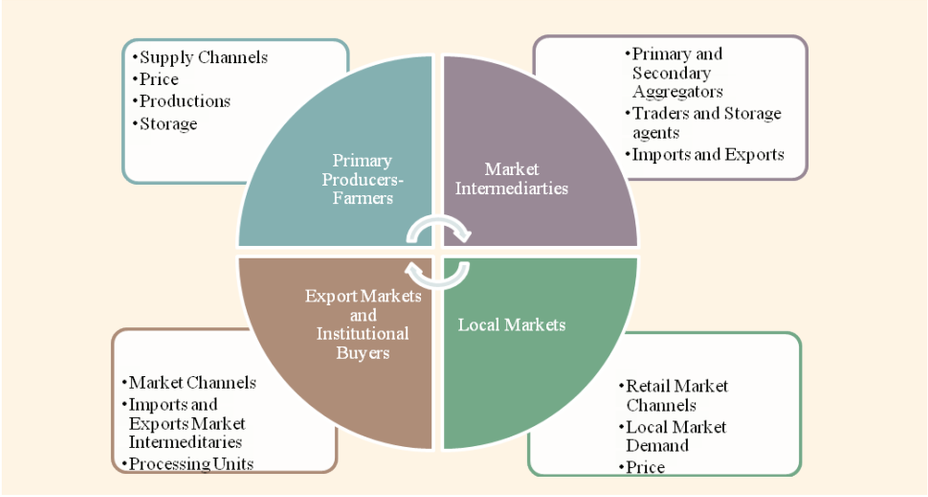


Figure 4: Value chain analysis framework

Present assignment focussed on value chain analysis of Mango and Arhar in Odisha which was planned to accomplish through following interconnected steps:

- Data collection and research
- Value chain mapping
- Identification of climatic risks and its impact
- Analysis of opportunities and constraints
- Validation of findings with stakeholders and
- Recommendations for future actions.

3.2.1 Sample Coverage and Tools

For fulfilment of the objective of the assignment, required information and data were collected from primary as well as secondary sources. The secondary data on cultivation, area, production, productivity, market and available infrastructure, etc. were collected from the State / district level horticulture and agriculture officials of the department, related web sites and available documents. Primary information and data were collected from the farmer households, farmer associations/organizations, Traders, market etc. Special focus was given on value addition in different nodes of the value chain, identification of present status, associated constraints and detailed analysis of Production to Consumption System. The farmers/growers were covered in the assessment from different production clusters/blocks. Sample villages, from each cluster were selected based on the Mango/Arhar growing area information collected from the department, local PRIs, villagers, local traders etc. Apart from farmer household coverage, Focus Group Discussions (FGDs) were also conducted in the selected clusters with the Mango/Arhar growers/farmer groups. Interaction with other stakeholders like traders/ market players, input dealers, processors, consumers, Farmer Producer Organizations (FPO) and officials of line department were done. Market research was also conducted in the neighbouring states (Vijayawada in Andhra Pradesh, Raipur in Chatisgarh, Ranchi in Jharkhand and Kolkata in West Bengal) to assess the supply chain behaviour beyond state boundary. All the collected information/data were crosschecked / triangulated and tabulated. Standard statistical tools like average, percentage and graphical presentations etc. were used for analysis, interpretation and infer conclusion to suit the assessment objectives. Detail stakeholder wise coverage of samples for value chain analysis is presented below.

Table 3: Sample coverage

SN	Particulars	Sample Coverage
1	State	1 (Odisha)
2	District	9 (Ganjam, Mayurbhanj, Sundargarh, Rayagada, Balasore, Kalahandi, Bolangir, Angul, Dhenkanal)
3	Agro climatic zone	8 (East and South Eastern Coastal Plain, North Central Plateau, North Western Plateau, Mid Central Table Land, North Eastern Coastal Plain, Western Undulating Zone, Western Central Table Land, North Eastern Ghat)
4	Crop/commodity	2 (Mango, Arhar)
5	Farmer	140
6	Focus Group Discussion (FGD)	24 (250 farmers)
7	Mandi/Market	12
8	Input dealer	18
9	Trader	41
10	Processing unit	14
11	Cold storage/ware house	4
12	Consumer	40
13	Lead Bank	6
14	Farmer Producer Organization	7
15	Govt. Official	21

Different types of tools were used to capture information from the identified clusters, covering different stakeholders at district and sub district level. The tools were designed for capturing both qualitative and quantitative information. The structured format / schedules, separately for each category of respondents were used to capture information. The category of stakeholders covered using the structured formats were individual Mango/Arhar growing farmers, traders, input dealers, consumers, processors. Semi-structured formats / schedule / checklist were used to elucidate information from the sample clusters through focus group discussion with Mango/Arhar growing farmers, producer group. Checklist/semi structured formats were also used to obtain required information from mandi/market, storage units, lead bank and Govt. Officials (Agriculture and Horticulture) at district and sub district level.

3.2.2 Stakeholder Mapping for Value Chain Analysis of the Selected Crops

A comprehensive analysis principle was adopted to understand the role of different entities in the value chain and its beneficial dimension for primary producer. Detailed mapping was carried out in a Production to Consumption System. The study was also focussed on climate change aspects of the value chain.

For analysing baseline situation of Mango and Arhar, a participatory and consultative approach was followed involving different stakeholders at different operational levels. At state level, designated officials of Directorate of Horticulture/Agriculture were consulted to understand the prospect, potentiality and constraints. Area and production data of Mango and Arhar in different districts during last five years were also collected from the respective Directorates for assessing production trends across the districts. At district and sub district level, Horticulture/Agriculture Officials of the Department were consulted for identification of Mango and Arhar growing clusters, Key institutional initiatives taken for the promotion of Mango and Arhar in the district under different schemes and programmes, constrains and opportunities, climatic risks and impacts as well as suggestions/ recommendation for development.

After finalisation of the clusters/blocks, study was conducted in the selected clusters by interacting with the value chain players at different levels and at different stages of value chain (pre-production, production, processing, marketing and consumption). Different stakeholders like Mango and Arhar growers, input dealers, market players/traders, processors, service providers and consumers were thoroughly interviewed on various facets of their involvement, role and contribution in the value chain. All the existing practices and processes were mapped to assess the current scenario and analyse the value chain of Arhar and Mango in the state.

3.2.3 Identification of Crop Specific Strategies

Existing strategies adopted by Arhar and Mango growers as well as other stakeholders at different stages of value chain (pre-production, production, processing, marketing and consumption) were identified and mapped during the study. Existing strategies and practices for use of varieties of planting material, cropping system and type of farming, integrated nutrient management, integrated pest management, irrigation management, use of farm implements and equipment, post-harvest management, primary value addition, packaging, storage, processing, transportation, supply chain management, marketing and business transaction have been assessed.

SECTION 4:

Climate Risk and Crop Specific Value Chain Insights

This section depicts the baseline scenario across different stages of the value chain like pre-production, production, processing, marketing and consumption of mango and arhar in Odisha.

4.1 Pre-Production

Pre-Production stage is the most important step in realizing better production. The stage includes selection and arranging of proper inputs like seed/planting material, plant nutrients, plant protection materials, farm implements/equipment, land/pit preparation, treatment, seed bed/nursery management, etc. Pre-Production plays a vital role in ensuring better productivity. Current scenario under pre-production stage of Mango and Arhar is portrayed here under.

4.1.1 Mango

4.1.1.1 Soil Testing

Soil test is important for several reasons: to optimize crop production, to protect the environment from contamination by runoff and leaching of excess fertilizers, to aid in the diagnosis of plant culture problems, to improve the nutritional balance of the growing media and to save money and conserve energy by applying appropriate dose of fertilizer needed. Though most of the Mango farmers aware of soil testing and its implications, only 40% of respondent farmers have done soil testing as shown in figure 5. Among them, 69 % of farmers have adopted the recommendation (figure-6). Adoption of soil test recommendation has positive impact on environment in terms of optimum use of fertilizer thus leading to less pollution of soil ecosystem and surface as well as ground water.

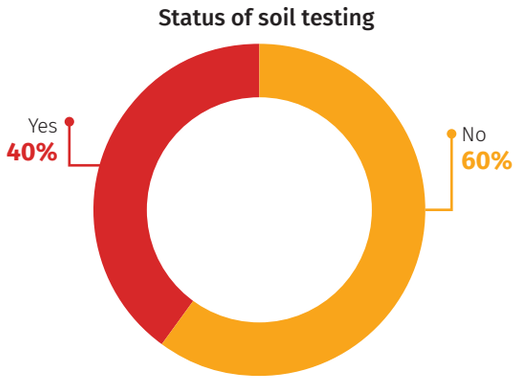


Figure 5: Soil testing status of mango growers

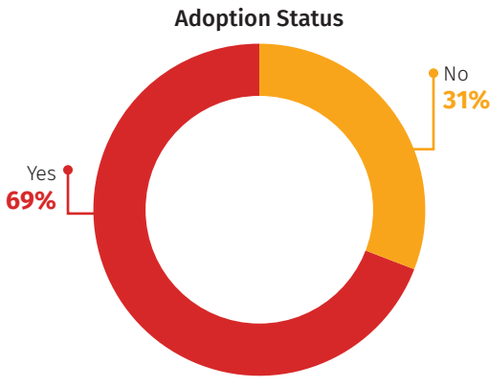


Figure 6: Soil testing recommendation adoption

4.1.1.2 Use of Variety and Source

Selection of suitable variety is vital for attaining optimum production. It is revealed from the study that 22.23 % of farmers have planted local variety. Currently new farmers who have taken up mango farming are preferring high yielding and hybrid varieties. 43.33 % of respondent farmers have preferred High yielding varieties, 34.44 % have planted Hybrid varieties as mentioned in the fig 7. The popular high yielding and hybrid varieties grown by farmers are Baiganpalei, Amrapalli, Lengra, Neelum, Mallika and Dasheri. Among these varieties, Baiganpalei is mostly preferred by the farmers.

The farmers are arranging the planting materials/saplings from various sources like Govt. Farms/nurseries, private nurseries, State Agriculture University and other sources. Study revealed that, 56.67% farmers arranged planting material from Govt. Source, 20% from private sources, 5.56% from State Agri-University and 17.78% from other sources like co-farmers, NGOs, self, etc. as depicted in fig 8.

.

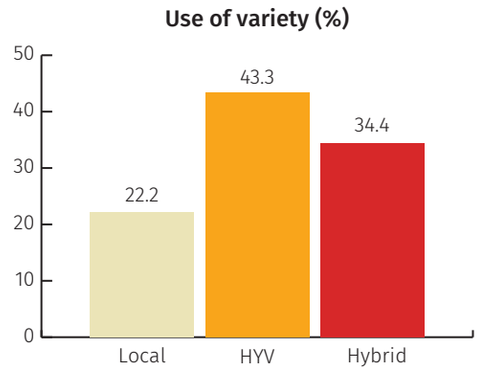


Figure 7: Status of Varieties used by farmers

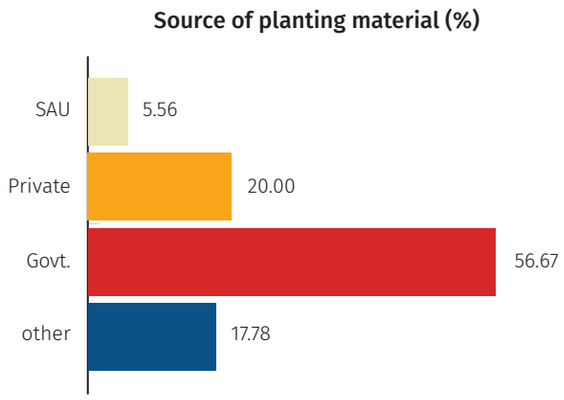


Figure 8: Source of Planting Material

Mango growers face climate risks like dry spell, wet spell, heat waves, hail storm, flood and cyclone during pre-production stage. Its impact and coping mechanism stage are elaborated below.

Table 4: Climate risks, impact & coping mechanism during pre-production stage of mango

Climate Risk	Impact	Coping mechanism
Dry spell	Vegetative growth of saplings affected, moisture stress condition, temporary wilting	Watering at frequent intervals
Wet spell	Water logging, poor drainage, sapling mortality, root rot	Raised bed, provision for drainage, gap filling
Heat wave	Wilting and drying of saplings	Watering at frequent intervals, shade net use by few
Hail storm	Leaf damage, sapling damage and mortality	Gap filling
Flood	Submergence/ wash out of nursery/ saplings	Draining excess water, shifting of saplings to safer place
Cyclone	Sapling damage and mortality	Seedling replacement, shifting of saplings to safer place

Woman members of the farm families/woman labour are engaged in seedling transplanting, watering and weeding in nurseries and also engaged for planting and watering in the mango orchards.

4.1.2 Arhar

4.1.2.1 Soil Testing

Arhar growing farmers are not very keen on soil testing. Only 32% of respondent farmers have done soil testing. 75% of them have adopted soil test recommendation as depicted in the figure 9 &10. Application of appropriate dose of nutrients as per the soil testing recommendation is safe for soil, water and air.

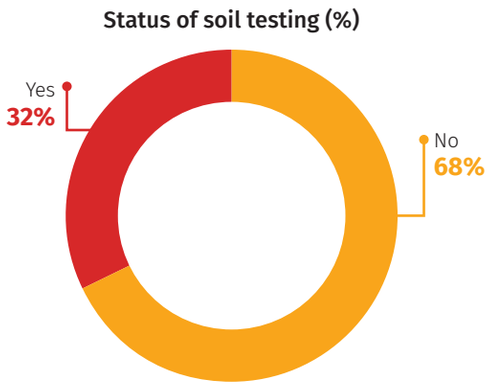


Figure 9: Status of soil testing by arhar growers

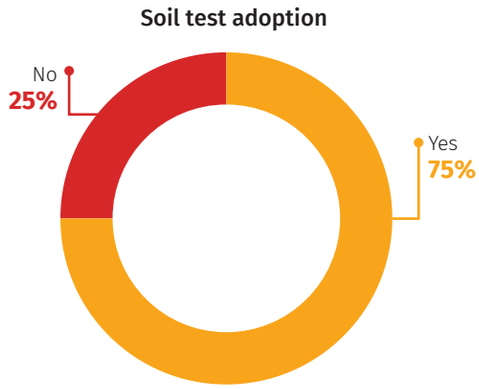


Figure 10: Status of Soil test adoption by arhar growers

4.1.2.2 Use of Variety and Source

Majority of the farmers (78%) are using local varieties where as only 22% prefer High yielding varieties. 58% of farmers use their own seed where as 38% arrange the seeds from Govt. Sources. Rest 4% arrange the seeds from other sources like co-farmers, etc. as mentioned in fig 11 & 12. More usage of local variety puts minimum pressure on soil ecosystem as fertilizer usage is minimum. In case of high yielding variety, to realise higher production, application of fertilizer and pesticide is at higher side which negatively affects the soil ecosystem and environment.

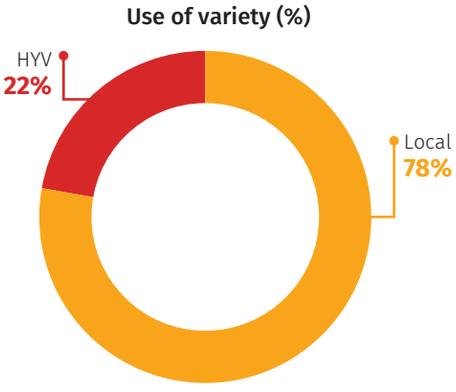


Figure 11: Use of variety of arhar

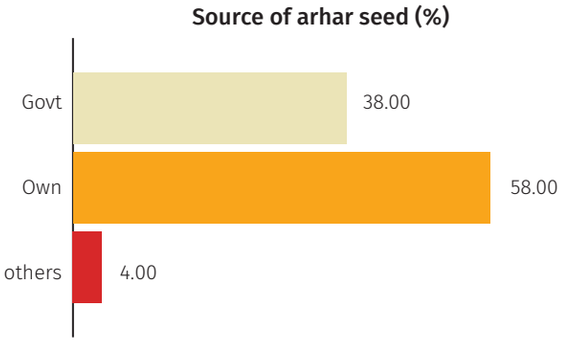


Figure 12: Source of arhar seed

Arhar growers face climate risks like dry spell, wet spell and flood situation during pre-production stage. Its impact and coping mechanism are elaborated below.

Table 5: Climate risks, impact and coping mechanism during pre-production stage of arhar

Climate Risk	Impact	Coping mechanism
Dry spell	Seed germination affected, moisture stress condition, effect on the germinated seeds	Watering at frequent intervals
Wet spell	Water logging, poor drainage, seed damage, root rot	Draining excess water, withdrawing watering, gap filling
Flood	Submergence/ wash out of seeds and germinated seeds	Draining excess water, re-sowing of other short-med duration pulses

Woman members of the farm families/woman labour are engaged in broadcasting of seeds/ sowing of seeds behind plough and related activities.

4.2 Production

Production stage comprises of all the farm operations from sowing/planting till harvest of the crop. Current strategies adopted during production stage by mango and arhar growers in the state are described here under.

4.2.1 Mango

4.2.1.1 Cropping System

Mango is mostly grown as mono crop. 77.66% of the respondent farmers are doing mono cropping where as 22.34% of the farmers grow other crops like pineapple, lemon and Arhar (during first 1 to 2 year) as intercrop with mango as mentioned in the fig 13. Intercropping increases diversity in agriculture ecosystem, maintain ecological balance and helps in reduction of weed, pest and diseases and more effective use of resources.

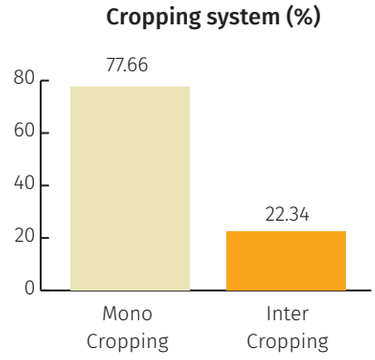


Figure 13: Cropping System in Mango

4.2.1.2 Irrigation

About 55.55% of the mango growers are providing irrigation from different sources while 44.44% depends on rainfall for survival of their matured and established trees.72% of farmers depends on wells and tube wells, 18% farmers depend on lift irrigation points, 8% of farmers depend on canal water and 2% depends on tanks as shown in fig 14. Most of the farmers (96%) are adopting basin, ring and furrow method of irrigation whereas only 4% of the respondent farmers adopted drip irrigation method as depicted from fig 15. The existing method of irrigation indicates low water use efficiency and wastage of water.

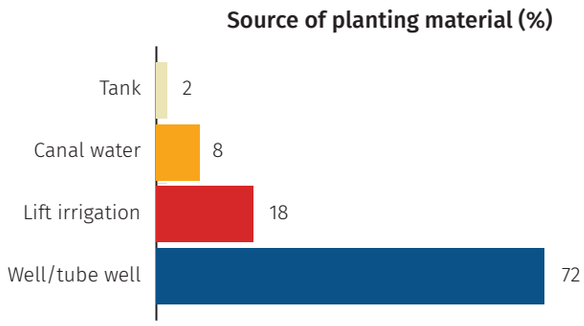


Figure 14: Source of Irrigation for mango farming

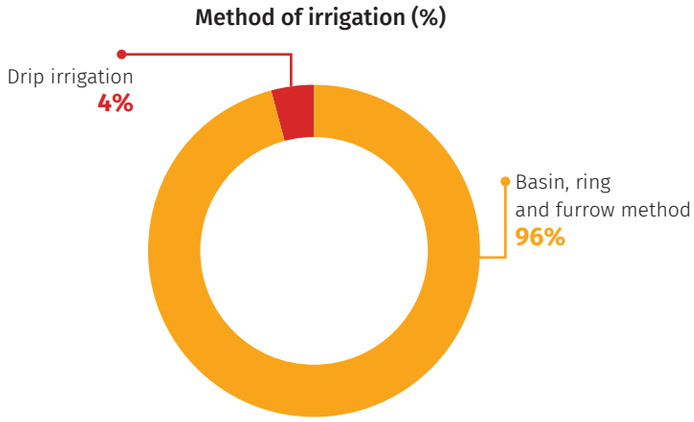


Figure 15: Method of irrigation by mango farmers

4.2.1.3 Integrated Nutrient Management

Mango Farmers apply both organic and inorganic fertilizer. 73.33% of mango farmers are using farm yard manure; whereas only 4.44% of farmers are using vermin compost and 2.22% are applying green manure as shown in fig 16. Regarding use of chemical fertilizers, 56.67% of farmers are applying urea, 6.67% and 3.33% of farmers are applying SSP and potash respectively as mentioned in fig 17. Only 5.56% of mango farmers are using bio fertilizer and 4.44% of the farmers are using micronutrients as presented in fig 18. The usage of organic manure enhances the microbial population in the soil, increases the water holding capacity of soil and improves the soil ecosystem. Use of chemical fertilizers puts pressure on the environment and degrades soil quality.

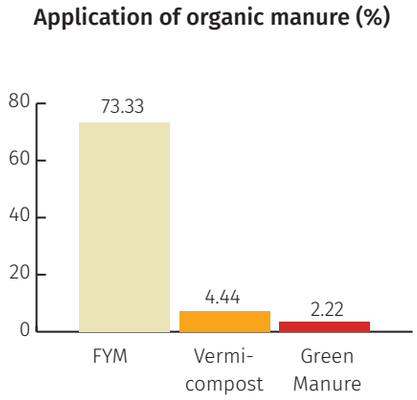


Figure 16: Application of Organic Manure in mango

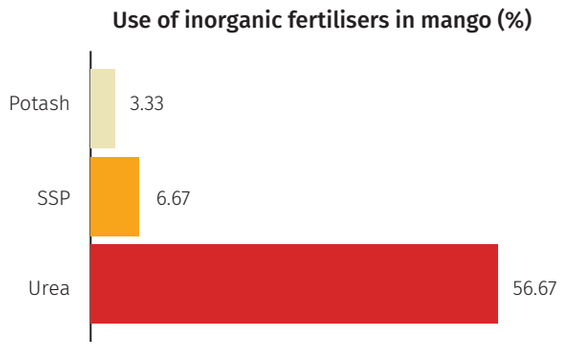


Figure 17: Application of Inorganic fertilisers in mango

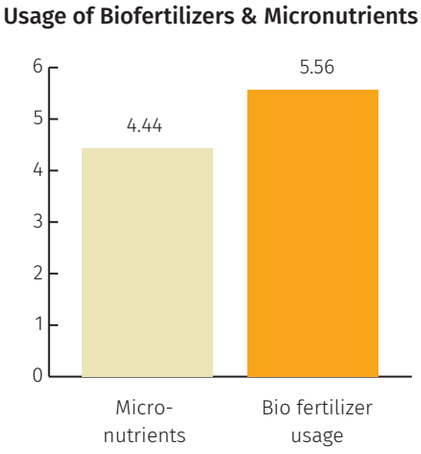


Figure 18: Use of bio fertiliser & micro nutrients in mango

4.2.1.4 Integrated Pest Management

Mango is mostly infested by mango hopper, mealy bug, fruit fly, stem borer and anthracnose. Regarding integrated pest management (IPM) practices, 75.55% of the mango farmers are using chemical/inorganic pesticides, 6.66% of farmers are using organic pesticides and 3.33% of the farmers are resorting to cultural practices like weeding, bush cleaning, drainage and other intercultural operations as depicted in the figure 19. More use of chemcial pestices are hazardous for the environment. On the contrary use of organic pesticides and conrolling of pest through cultural practices protect the nature.

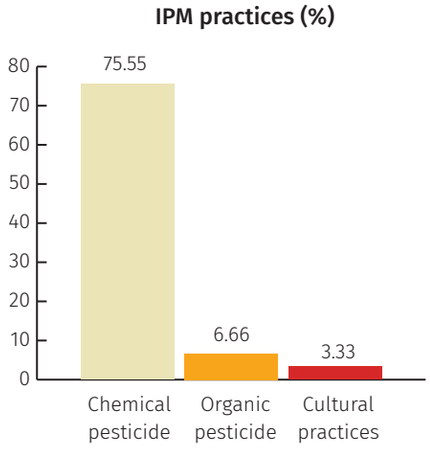


Figure 19: IPM Practices of mango farmers

4.2.1.5 Farm Mechanization

Regarding farm mechanization, 75.56% of the farmers are using manual/hand operated equipment and 35.56% of farmers are using power operated equipment for mango cultivation as mentioned in fig 20. The power operated equipment used energy and in the process emits harmful gases which pollute the environment.

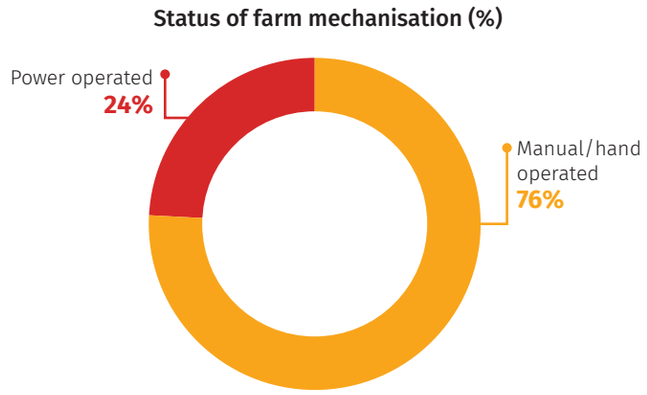


Figure 20: Status of farm mechanisation in mango

4.2.1.6 Access to Information

The mango producers are exposed to agriculture information from various sources. 38.89% of the respondent mango farmers are getting information from Agri extension personnel, 21.11% farmers are exposed to Agri related programs and information through electronic & print media (in television and local newspaper), 15.56% of farmers are getting benefits from Govt. Programs, 14.44% of farmers have access to market information of local markets and 2.22% of farmers have access to crop & weather information as evident from the figure 21. The access to information helps farmers in taking appropriate decision for adopting sustainable and climate resilient agriculture practices.

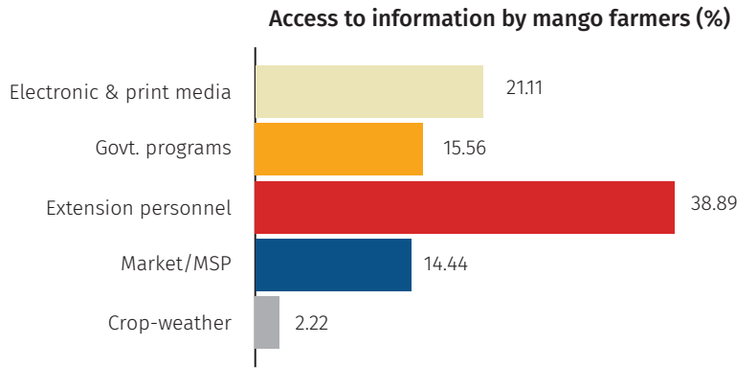


Figure 21: Access to information by mango farmers

Mango growers face climate risks like dry spell, wet spell, heat waves, hail storm, flood and cyclone during production stage.

Its impact and coping mechanism are elaborated below.

Table 6: Climate risks, impact and coping mechanism during production stage of mango

Climate Risk	Impact	Coping mechanism
Dry spell	Vegetative growth of young plants affected, moisture stress condition, temporary wilting of young plants	Watering at frequent intervals
Wet spell	Water logging, poor drainage, root rot in freshly planted saplings, drop/damage of mango flower/inflorescence	Draining of excess water from root zone, earthing up at base of the plant
Heat wave	Temporary wilting and drying of freshly planted saplings and tender plants, leaf and flower/inflorescence affected	Watering at frequent intervals, spraying of water to plants
Hail storm	leaf and flower/inflorescence damage, tender fruit drop, effect to fruits	Removal of broken twigs/ branches and damaged fruits and leaves
Flood	Submergence/ water logging	Draining of excess water from root zone, earthing up at base of the plant after water recedes
Cyclone/ Depression	Uprooting of trees, damage to flowers/inflorescence, fruits and leaves	Removal of broken twigs/ branches and damaged fruits and leaves, cleaning of orchard/farm, gap filling/replacement of tender plants

Woman members of the farm families/woman labour are engaged in weeding, watering, harvesting/plucking and intercultural operations.

Productivity of mango as per the sample farmers ranges from 0.5 Mt to 2MT per acre. The state average is 1.52 MT per acre.

Mango is produced in almost all districts of Odisha. The top ten mango producing districts in Odisha during 2015-16[12] are Rayagada (54379MT), Angul (51554 MT), Mayurbhanj (51031MT), Dhenkanal (44452MT), Koraput (44117MT), Kalahandi (43978MT), Keonjhar (42659MT), Sundergarh (39314MT), Ganjam (38290MT) and Kandhamal (30672MT). District wise production of mango in Odisha during 2015-16 is displayed in figure 22.

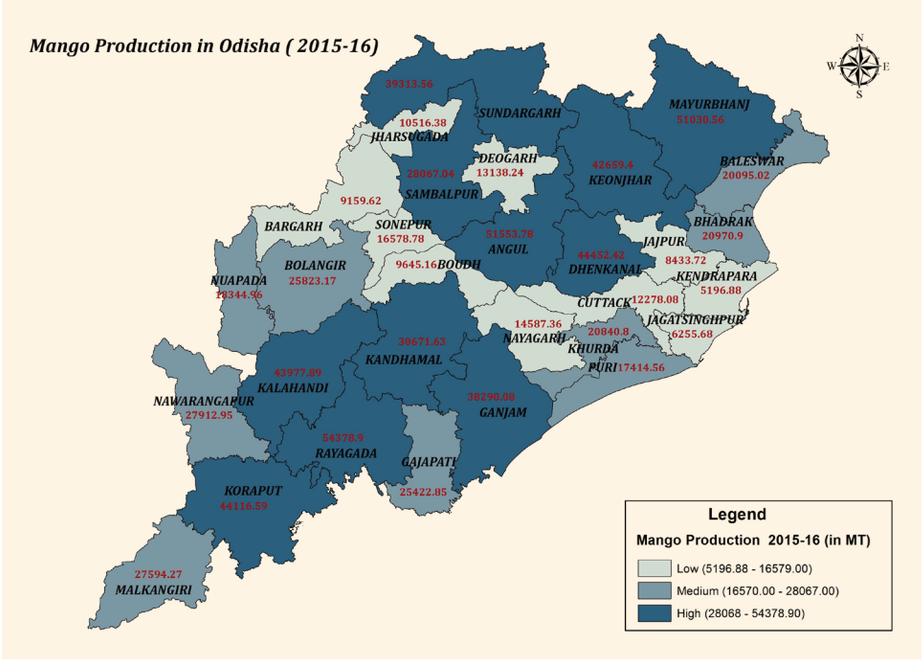


Figure 22: Mango production in Odisha (2015-16)

The production and productivity trend of mango as well as the rainfall pattern in the study districts during last five years are presented below (figure 23).

12 Directorate of Horticulture, Govt. of Odisha

It can be inferred from the above figure that; rainfall pattern in the study districts during the last five years has no implications on the production/ productivity trend of mango. This confirms that, mango is a climate resilient crop.

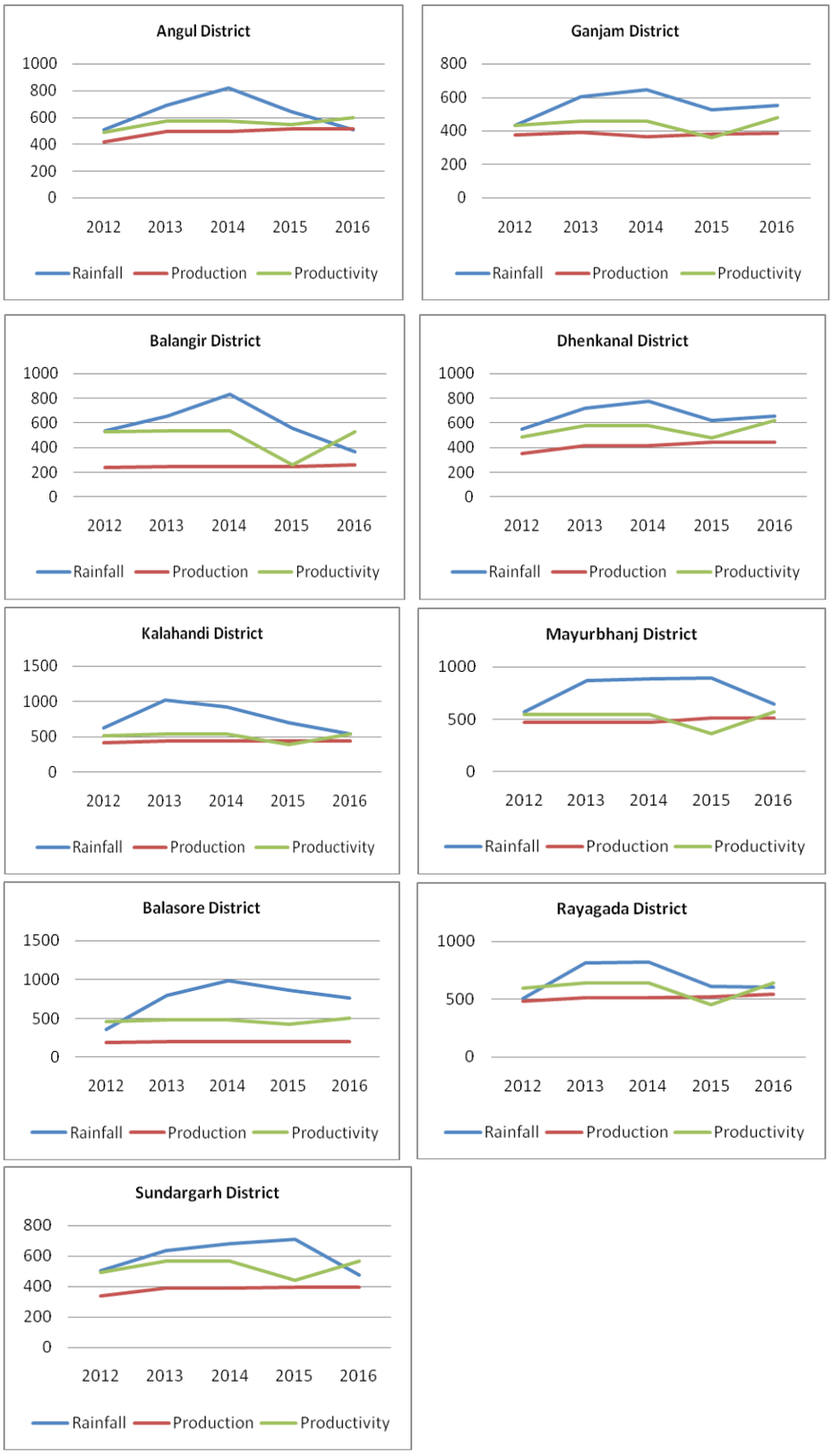


Figure 23: Production & Productivity Trend of Mango and Rainfall pattern in the Study Districts

Source: Directorate of Horticulture, Directorate of Agriculture & Food Production, Odisha (Rainfall in mm, Production in '0 MT, Productivity in Qt/Ha)

4.2.2 Arhar

4.2.2.1 Cropping System

Arhar is cultivated by the farmers as mono/sole crop, inter crop, mixed crop and bund plantation. It can be inferred from figure 24 that, 48% the of farmers are growing Arhar as intercrop with cotton and ground nut, 42% of the farmers grow Arhar in paddy bunds and 10% of the farmers are growing Arhar as mono/sole crop. Since most of the farmers are preferring intercropping and bund plantation, its implications on the environment seems positive as the existing cropping system shall contribute to less occurrence of weed, pest and diseases and maintenance of ecosystem.

4.2.2.2 Integrated Nutrient Management

Farmers growing arhar in paddy bunds do not have the practice of applying any plant nutrients to the arhar crop where as others apply both organic and inorganic plant nutrients.36% of the farmers apply only urea, 12% farmers apply SSP and urea both and 6% apply potash along with urea and SSP to the crop as shown in the fig 25. Farm yard manure is applied by most of the farmers. While applying the plant nutrients, 38% of them adopt broadcasting method, 20% farmers apply it behind the plough and 4% apply at root zone of the plants as depicted from the fig 26. In broadcasting method, the plant nutrients are not fully incorporated in the soil as most of the nutrients are lost to the atmosphere through evaporation thus polluting the environment.

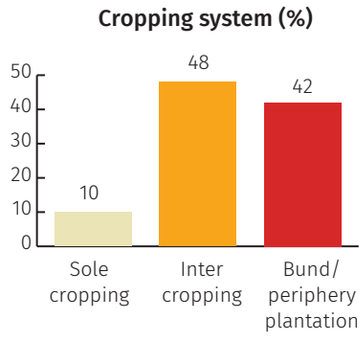


Figure 24: Cropping System in Arhar

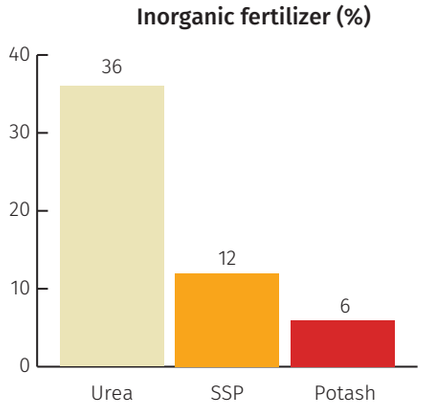


Figure 25: Inorganic Fertilizer use by arhar farmers

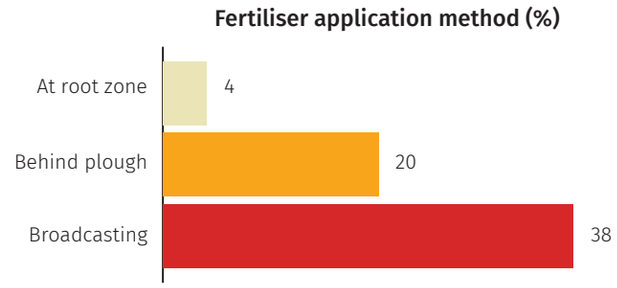


Figure 26: Methods of fertiliser application in arhar

4.2.2.3 Irrigation

Arhar is mostly grown as rain fed crop. 88% farmers depend on rainfall and only 12% of the respondent farmers irrigate from well/tube well, lift irrigation points and canal water during time of need. Among those who provide irrigation to Arhar crop, 50% of the farmer depends on well/ tube well, 33.33% depends on LI points and 16.66% depends on canal water as portrayed in the figure 27. Pressure on the water resources is less due to less dependency on irrigation water.

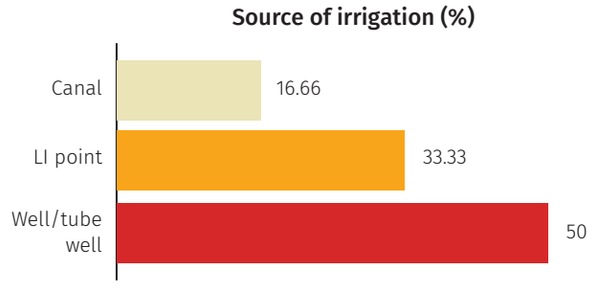


Figure 27: Source of Irrigation

4.2.2.4 Integrated Pest Management

Arhar crop is mostly infested by pod borer, pod fly, hairy caterpillar, leaf hopper, wilt, stem rot, etc. Regarding integrated pest management (IPM) practices, 56% of the Arhar farmers are using chemical/inorganic pesticides, 4% of farmers are using organic pesticides and 10% of the farmers are resorting to cultural practices like weeding, drainage, growing along with other crops and other intercultural operations as depicted in fig 28. Dependency on chemical pesticides shall contribute more to environmental pollution.

4.2.2.5 Farm Mechanization

Regarding farm mechanization, 88% of the farmers using manual/hand operated equipment and 12% of farmers are using power operated equipment for Arhar cultivation as mentioned in the figure 29. As very less percentage of respondent farmers are using power operated equipment, their contribution to environmental pollution is less.

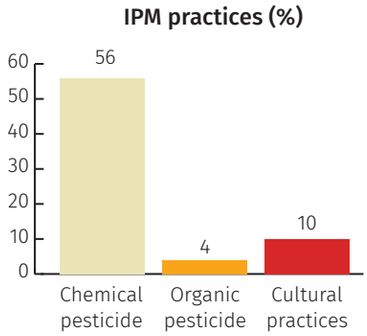


Figure 28: IPM practices of arhar farmers

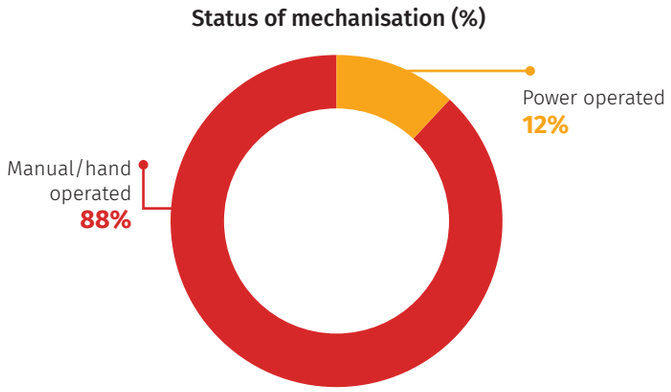


Figure 29: Status of farm mechanisation in arhar

4.2.2.6 Access to Information

The Arhar farmers are exposed to agriculture information from various sources. About 76% of the Arhar farmers have access to market information about the local market , 8% farmers are getting extension services from the local extension personnel and 4% farmers are exposed to agriculture related programs and information through television and local dailies as mentioned in fig 30. The access to information helps farmers in taking appropriate decision for adopting sustainable and climate resilient agriculture practices.

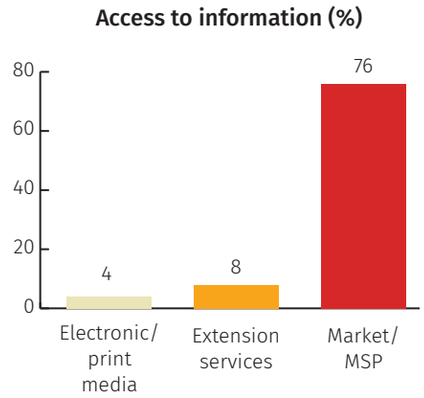


Figure 30: Access to information by arhar farmers

Arhar growers face climate risks like dry spell, wet spell, heat waves, hail storm, flood and cyclone during production stage. Its impact and coping mechanism are elaborated below.

Table 7: Climate risks, impact and coping mechanism of Arhar during production stage

Climate Risk	Impact	Coping mechanism
Dry spell	Vegetative growth of tender plants affected, moisture stress condition, temporary wilting of tender plants	Watering at frequent intervals
Wet spell	Water logging, poor drainage, root rot in tender plants, pest incidence, effect on flowers and pods	Draining of excess water from root zone, earthing up at base of the plant
Hail storm	Damage of leaves, flowers and pods	Removal of broken twigs/ branches and damaged pods and leaves
Flood	Submergence/ water logging	Draining of excess water from root zone, earthing up at base of the plant after water recedes
Cyclone	Damage of leaves, flowers, pods and plants	Removal of broken twigs/ branches and damaged pods and leaves, cleaning of farm, gap filling/replacement of tender plants

Woman members of the farm families/woman labour are engaged in weeding, watering, harvesting, threshing and intercultural operations.

Productivity of Arhar as per the respondent farmers ranges from 2.1 Qt to 3.6 Qt per acre. State average is 3.52 Qt per acre.

Arhar is produced in almost all districts in Odisha. Top ten Arhar producing districts in Odisha during 2015-16[13] are Rayagada (23160MT), Kalahandi (19230MT), Ganjam (117430MT), Angul (8160MT), Mayurbhanj (7670MT), Bolangir (6810MT), Sundargarh (6310MT), Kandhamal (4460MT), Keonjhar (4270MT) and Subarnapur (3470MT). District wise production of arhar in Odisha during 2015-16 is presented in the figure 31.

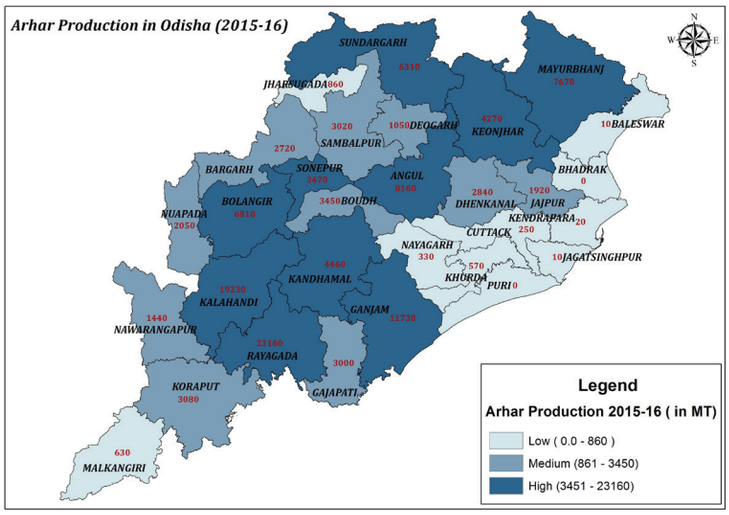
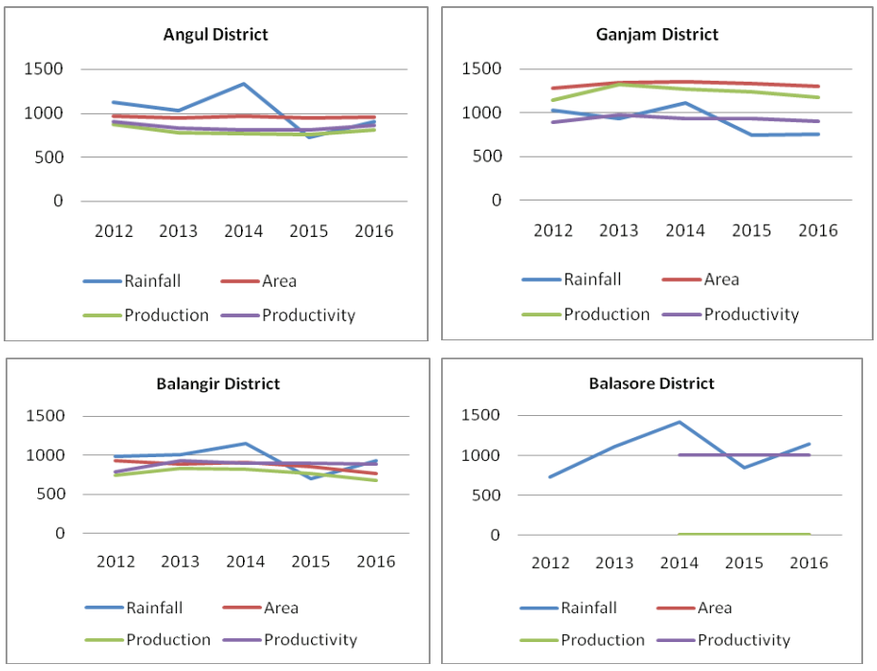


Figure 31: Arhar production in Odisha (2015-16)

The area, production and productivity trend of arhar as well as the rainfall pattern in the study districts during last five years are displayed in the figure 32. The figure depicts that; rainfall pattern in the study districts during the last five years has no significant implications on the area/production/productivity trend of arhar. This indicates that, arhar is a climate resilient crop.



13 Directorate of Agriculture & Food Production, Govt. of Odisha

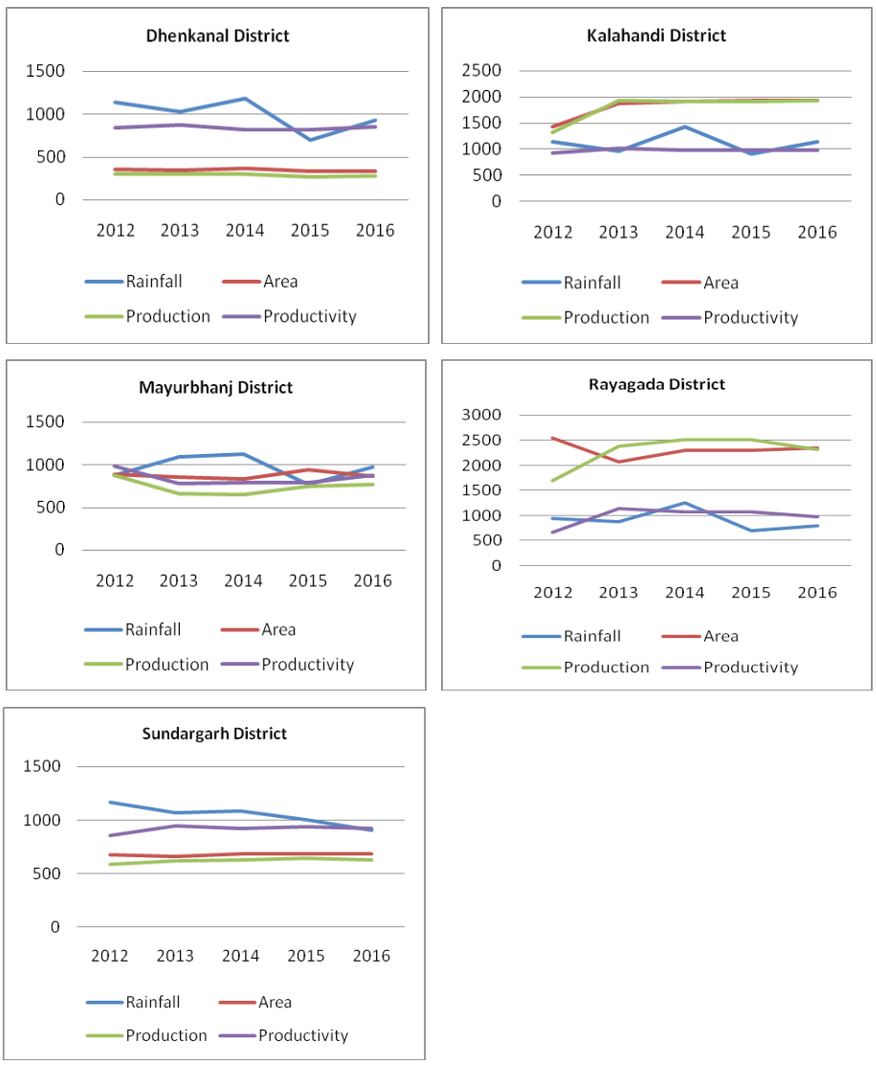


Figure 32: Area, Production, Productivity Trend of Arhar and Rainfall Pattern in Study Districts

Source: Directorate of Agriculture & Food Production, Odisha
(Rainfall in mm, Area in '0 Ha, Production in '0 MT, Productivity in Kg/Ha)

4.3 Processing

Processing comprises of techno economic activities carried out for conservation and handling of agricultural produce to make it usable as food. Current scenario of post harvest management and processing of mango and arhar as revealed from the study are elaborated here under.

4.3.1 Mango

Primary value addition activities like cleaning, washing, drying, sorting and grading of mango are done by the farmers after harvest. 10% of respondent farmers are cleaning/ washing the harvested mangoes, 5.56% of farmer are drying in shade after washing. 2.22% of farmers are sorting the mangoes (after washing and drying) for marketing and 2.22% farmers are grading the mangoes as per size before selling. Rest of the farmers are not keen on primary value addition of the harvested mangoes. They sell it as such in the local market/haat or sell to the local traders as mentioned in fig 33. Primary value addition of mangoes enhances the cleanliness, palatability and shelf life. It removes the pollutants, dust, dirt and harmful matters from the fruit and prevents contamination.

Green mangoes are sold in the market/haat or sold to the local traders or used for pickle making by the house hold. Green mangoes are also kept for ripening by putting it above straw/hay for 3 to 4 days and then sold it in the local market/haat or sold it to village trader.

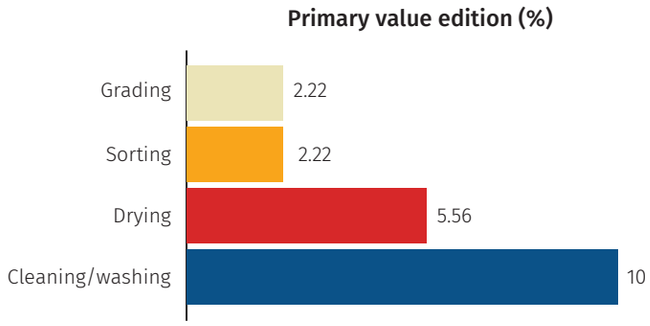


Figure 33: Primary Value addition of Mango

Processed products like mango pickles, mango drink, dried mango, mango jam, etc. are being prepared and sold in the market. The processing units procure green and ripe mangoes from different sources and places for preparing the processed products of mango. It is evident from the figure 34 that, 60% of the processors procure mango from the farmers, 20% from the wholesalers while another 20% procure from the agents. Most of the processing units (80%) procure the mangoes from within the district while 20% procure from outside to meet the requirement as presented in figure 35. The household processing do not contribute much to the environmental pollution as compared to commercial processing.

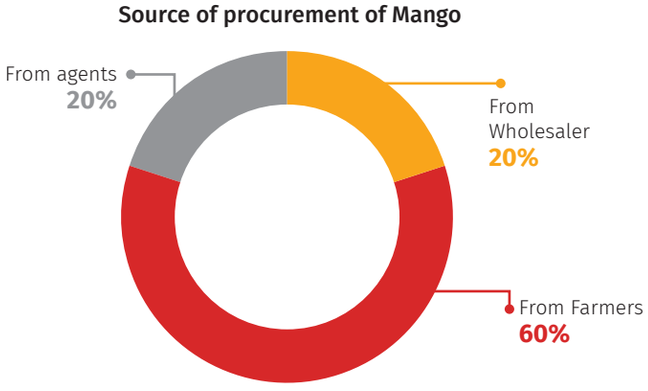


Figure 34: Source of procurement of mango

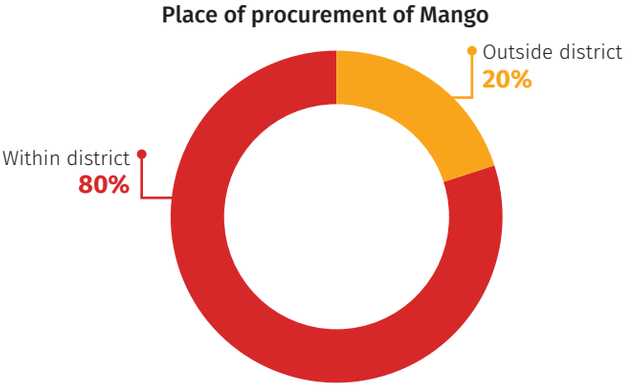


Figure 35: Place of procurement of mango

After processing, mango products are sold in the market. It is evident from figure 36 that, 50% of the processors sell mango products within the district, 25% sell both within and outside district while rest 25% sell within/outside district as well as outside state. The procurement of raw material from different places as well as selling of the processed mango involve use of transport thus contributing to environmental pollution through vehicular emissions.

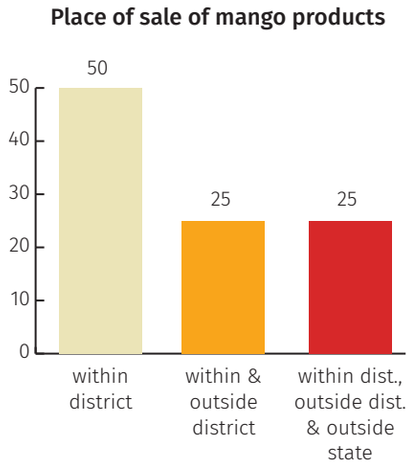


Figure 36: Place of sale of mango *products*

Impact of the climate risks and coping mechanism during processing stage is narrated below.

Table 8: Climate risks, impact and coping mechanism of Mango during processing stage

Climate Risk	Impact	Coping mechanism
Wet spell	Raw material supply and product delivery affected, quality deterioration of mango stock, process of pickle making and sun drying of mango affected	Preventing the raw materials and mango stock from getting wet
Flood	Water logging, poor drainage, wastage of raw material and products under processing, Raw material supply and product delivery affected, power supply affected	Draining of excess water from processing unit/ room, restoration of power supply through alternate arrangements, shifting of processed products to a safer place.
Cyclone	Damage of processing unit/facility, Raw material supply and product delivery affected, human labour absence, processing work affected	Reorganising and restoring processing work, rearrange raw materials

Woman members of the farm families/woman labour are engaged in cleaning/washing, sorting, grading of harvested mangoes, splitting, de stoning, drying of raw mangoes, pickle making, etc.

4.3.2 Arhar

After harvesting, arhar plants are bundled and placed upright to dry for a week depending on weather conditions. Pods and grains are separated by beating the dry plants by sticks or spreading the dry plants on the concrete road for open threshing under plying vehicles. The grains are kept open for 2 to 3 days for drying and then cleaned by removing inert matters and debris. Farmers are mostly storing their whole grain by mixing it with locally available red soil or by keeping Begunia leaf in the container to protect from storage insects/pests. Woman members of the farm families make in house dry fry of the grains to de-husk and manually stone grinding to split the grain for making dal for home consumption. Some farmers depend on small dal mills for de-husking and splitting of the grains. Commercial processors are preparing processed arhar dal with polishing

to increase marketability. The household processing of Arhar contributes less to the environment pollution than commercial processing.

Majority of the processors (70%) are procuring unprocessed arhar from the farmers while 30% procure it from the agents as mentioned in figure 37. About 77.8% of the processors are procuring arhar within the district while 22.2% procure it from outside district & state to meet their requirement as depicted from the figure 38.

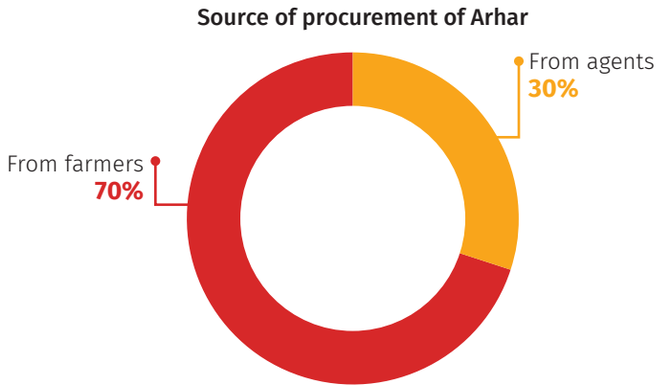


Figure 37: Source of procurement of Arhar

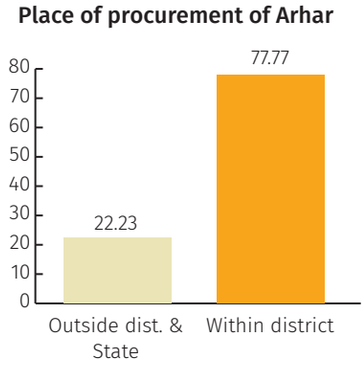


Figure 38: Place of procurement of Arhar

Almost all the processors sell their processed Arhar/ Arhar dal within the district. 50% of them sell Arhar dal within and outside the district where as 30% of the processors sell Arhar dal within and outside district and also to neighbouring states as shown in figure 39.

Both procurement as well as selling process contributes to environment pollution through vehicular emissions.

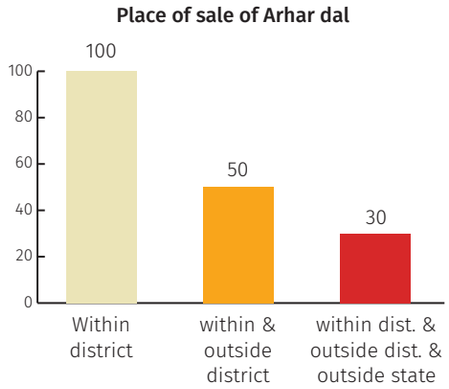


Figure 39: Place of sale of Arhar dal

Arhar processing activities are affected by the climate risks like wet spell, flood and cyclone. Its impact and coping mechanism during processing stage are presented below.

Table 9: Climate risks, impact and coping mechanism of Arhar during processing stage

Climate Risk	Impact	Coping mechanism
Wet spell	Raw material supply and product delivery affected, quality deterioration of grain	Preventing the raw materials and grain stock from getting wet
Flood	Water logging, poor drainage, wastage of raw material and products under processing, Raw material supply and product delivery affected, power supply affected	Draining of excess water from processing unit/ room, restoration of power supply through alternate arrangements, shifting of processed products to a safer place.
Cyclone	Damage of processing unit/facility, Raw material supply and product delivery affected, human labour absence, processing work affected	Reorganising and restoring processing work, rearrange raw materials

4.4 Marketing

Marketing is the key stage in the commodity value chain which includes the activities and the services involved in moving the commodity from producer to consumer. Current scenario of marketing of mango and Arhar to reach target consumers as revealed from the study are elaborated here under.

4.4.1 Mango

4.4.1.1 Place of sale

The mango growers are selling their produce at different places like at farm gate, village haat/mandi, whole sale market, outside district and outside state. It is depicted from the figure 40 that, 48.54% of the mango producers sell at farm gate, 22.33% sell at village haat/mandi, only 3% sell at wholesale market, 18.45% sell at nearby town while 3.88% of the respondents sell their produce beyond the district. The transportation of mango for selling puts lot of pressure on the environment through vehicular emission.

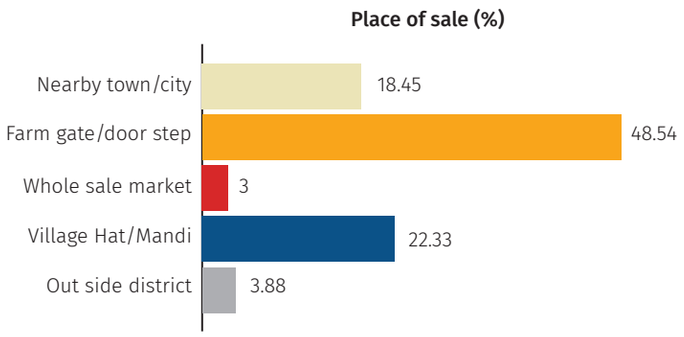


Figure 40: Place of Sale by mango producers

4.4.1.2 Packaging

For packaging of mango, as derived from the figure 41, about 11.11% of farmers are using plastic crates, 3.33% of farmers are using gunny bags while only 1.11% are using polythene bag as packaging material. Rest of farmers are used to sell their produce without packaging and sometimes traders do packaging after buying from farmers. Bio degradable and recyclable packaging materials are eco friendly.

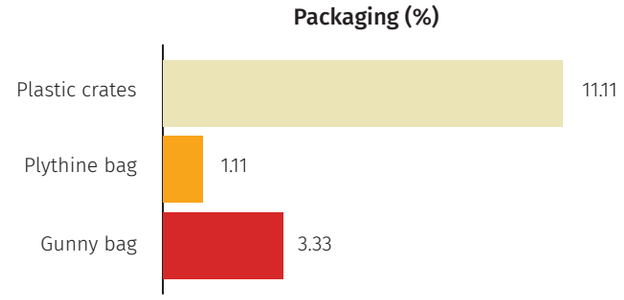


Figure 41: Packaging of mango

4.4.1.3 Price Satisfaction Level

Regarding price satisfaction level of the mango producers,37.78% of them are less satisfied, 27.78% of the farmers have medium level of satisfaction, 14.44% of farmers are highly satisfied with the price their produce fetch while another 14.44% of farmers have resorted to distress sale as presented in the chart (fig 42).

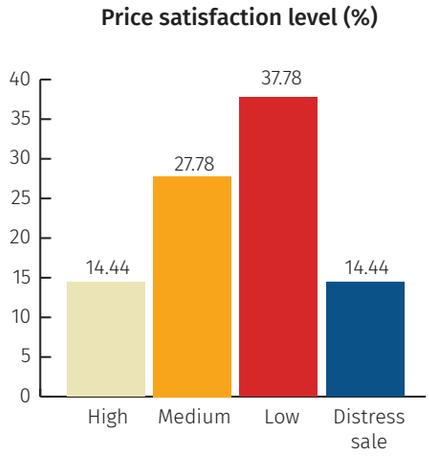


Figure 42: Price Satisfaction level of mango farmers

4.4.1.4 Supply Chain

As per the respondent farmers, mango moves through five different supply chains to reach the consumer. Fig 43 depicts that, major portion of the produce (58.51%) flows from farmers to consumers through traders, wholesalers and retailers followed by 21.18% of the produce reaching consumers directly from the farmer, 17.04% produce flows through wholesalers and retailers to reach consumers from the farmers. Only 1.02% farmers sell their mango to the processors who are procuring it mainly for pickle making. Price build up across different levels in the supply chain are in the range of 20%-50%.

The supply chain as mentioned in figure 43 prevails during normal condition. During climatic abnormal situation, the supply chain gets disturbed and changes according to the nature and intensity of the climatic hazard. During harvesting time in case of hazard the farmer tries to sell the produce at lower price to avoid the loss. The traders at the time of hazard try to hoard the commodity for selling it at a higher price. Supply is affected due to abnormal climatic conditions and thus price shoots up.

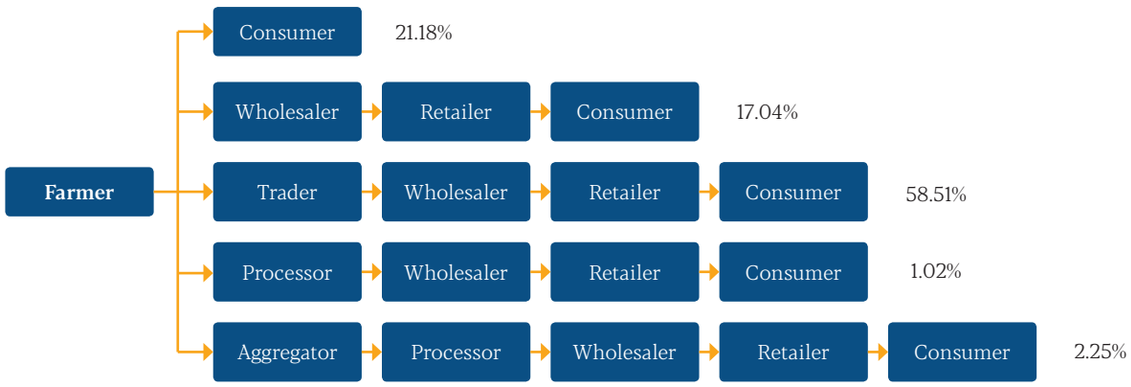


Figure 43: Supply chains for mango

Mangoes from most of the mango producing districts in the state are being supplied to and/or procured from other districts for marketing and the districts along the state boundary are having transaction with the adjacent states for supply and/or procurement of mango. It is evident from figure 44 that, from Dhenkanal, mango is supplied to Delhi and also to Cuttack and Khurda. Angul supplies mango to Cuttack and Khurda and also procures mango from those districts. Mangoes from Chhattisgarh and AP are supplied to Kalahandi district and from Kalahandi district it is supplied to Khurda, Balangir, Bargarh and Sambalpur. The flow of mango across the districts and states for marketing is displayed in the figure 44.

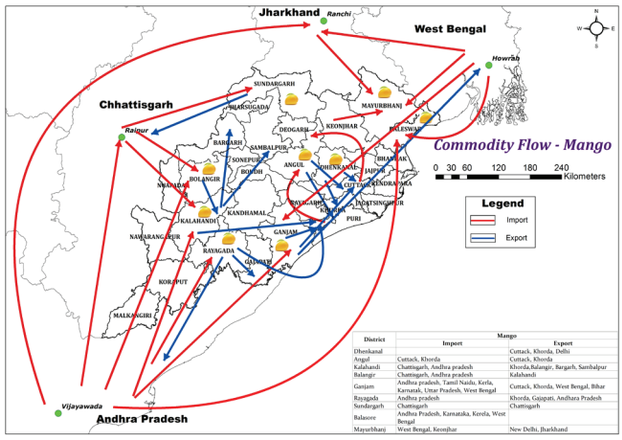


Figure 44: Commodity Flow - Mango

Following charts (fig-45 & 46) shows the arrival and price of mango at different markets of Odisha during 2016.

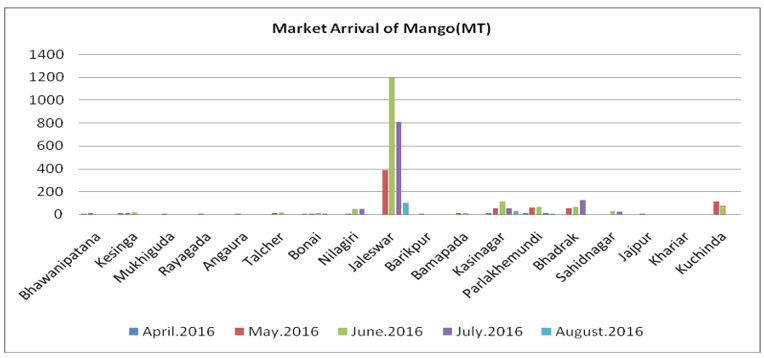


Figure 45: Market arrival of Mango during 2016

Source: http://agmarknet.gov.in

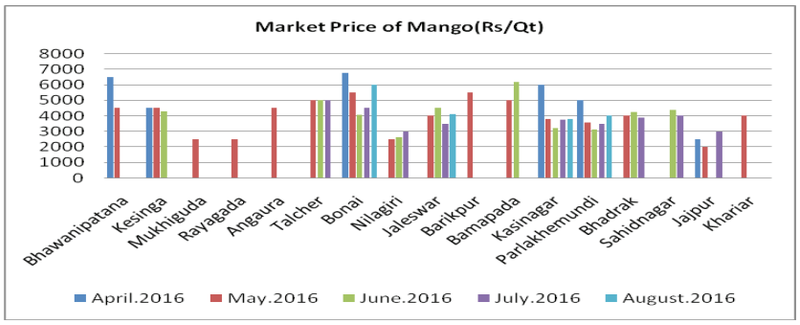


Figure 46: Market price of Mango during 2016

Source: http://agmarknet.gov.in

Price trend of mango during last five years as presented in the figure 47 depicts that; market price remains high during the month of April and August in comparison to the market price during May, June and July. Year wise and month wise market price of mango has been displayed in the following chart (fig 47)

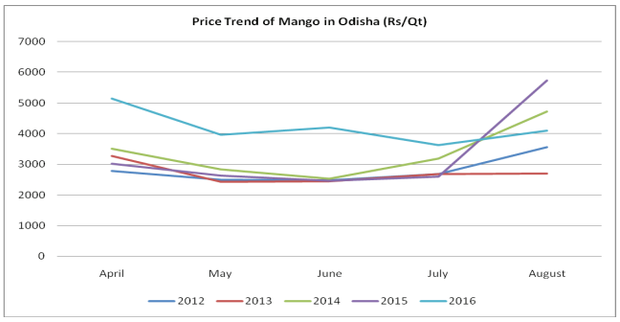


Figure 47: Price Trend of Mango in Odisha

Source: http://agmarknet.gov.in

Marketing of mango and its products are affected by the climate risks like wet spell, flood and cyclone. Its impact and coping mechanism are elaborated below.

Table 10: Climate risks, impact and coping mechanism during marketing stage of Mango and its products

Climate Risk	Impact	Coping mechanism
Wet spell	Effect on product supply, selling and price, deterioration of quality	Preventing the stock from getting wet, planning based on weather forecast
Flood	Water logging, poor drainage, wastage of products, effect on power supply, effect on transportation, product supply and transaction	Draining of excess water from market yard, stores and counters, restoration of power supply through alternate arrangements, shifting of products to safer place
Cyclone	Effect on transportation and supply, damage/wastage of products meant for sale, effect on power supply and sale	Reorganising and restoring the marketing process

Woman members of the farm families are engaged in selling green, ripe and dried mango in the local market/haat.

4.4.2 Arhar

4.4.2.1 Place of Sale

Arhar is mostly grown as subsistence crop and not grown commercially. Majority of the produce (72.13%) is used for home-consumption. It is evident from the figure 48 that, out of the total marketable surplus (27.86%), 79.01% is sold at door step/farm gate, 15.11% at

village hat and 5.88% of produce is sold at wholesale market. The transportation of arhar puts pressure on environment through vehicular emission.

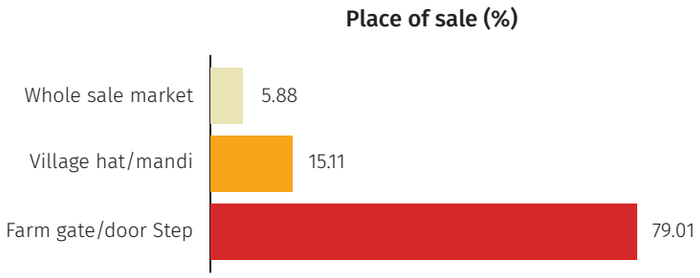


Figure 48: Place of sale of arhar

4.4.2.2 Packaging

Farmers are mostly using gunny bags as packaging material for Arhar. Polythene bags are mostly used as packaging material for Arhar dal. Use of polythene as packing material for Arhar dal is not healthy for the environment.

4.4.2.3 Price satisfaction level

Regarding price satisfaction level of the Arhar growers, 38% of the respondent farmers are moderately satisfied with the selling price and satisfaction level of 36% of the farmers is low. Only 10% of farmers are highly satisfied with the price they are getting from selling Arhar while 12% of farmers have resorted to distress sale as depicted in the figure 49.

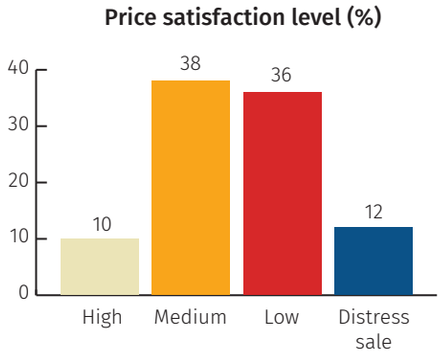


Figure 49: Price satisfaction Level of *arhar farmers*

4.4.2.1 Supply chain

As opined by the respondent farmers, Arhar mostly flows through two different supply chains for marketing as displayed in figure 50. Major portion of the produce (66.71%) flows from farmers to consumers through small traders, big traders, processor, wholesalers and retailers. Rest 33.29% of the marketable Arhar is sold to the consumers directly by the Arhar growers. Price build up across different levels in the supply chains are in the range of 15%-20%.

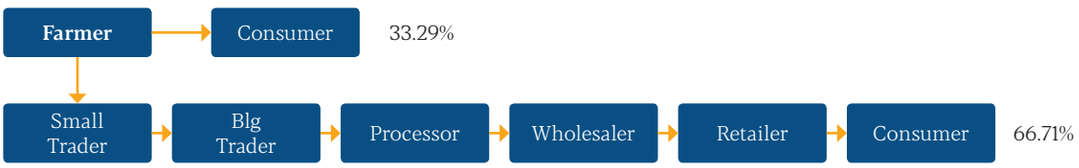


Figure 50: Supply chain of Arhar

During climatic abnormal situation the supply chain gets disturbed depending on the nature and intensity of situation. The traders take advantage of the situation and sell

Arhar dal at a higher price looking into the demand and panics of the consumer. The supply of Arhar dal in the market is affected due abnormal weather condition and thus price shoots up.

The flow of Arhar across the districts and states for marketing is presented in the commodity flow map (fig 51). It is evident from the figure that, Arhar from most of the Arhar producing districts in the state are supplied to and/or procured from other districts and states for marketing. Dhenkanal district is receiving Arhar dal from Cuttack, Angul is procuring Arhar from Khurda, Chhattisgarh and Maharashtra. The Kalahandi and Balangir is procuring Arhar dal from Chhattisgarh (Raipur). The detail commodity flow of Arhar is displayed in the figure 51.

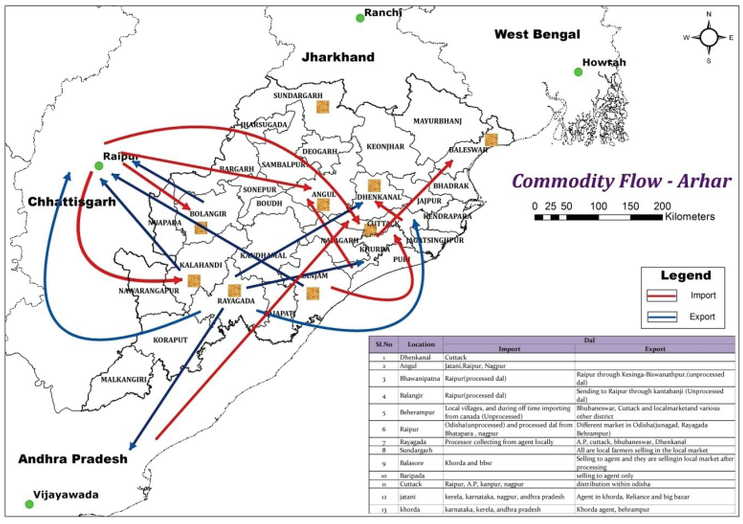


Figure 51: Commodity Flow- Arhar

Price trend of Arhar during last five years is presented in the figure 50. Year wise trend shows that, market price of Arhar was high during March in 2012, during July in 2013, during March and April in 2014, during May, June and December in 2015 and during March in 2016. Market price remained low during February and July in 2012, during January and February in 2013, during August to October in 2014, during January and February in 2015 and during February in 2016. Average trend shows that, market price remains high during the month of March and April and remains low in January and February in comparison to the market price during rest of the months. Year wise and month wise market price of Arhar is shown in the figure 52.

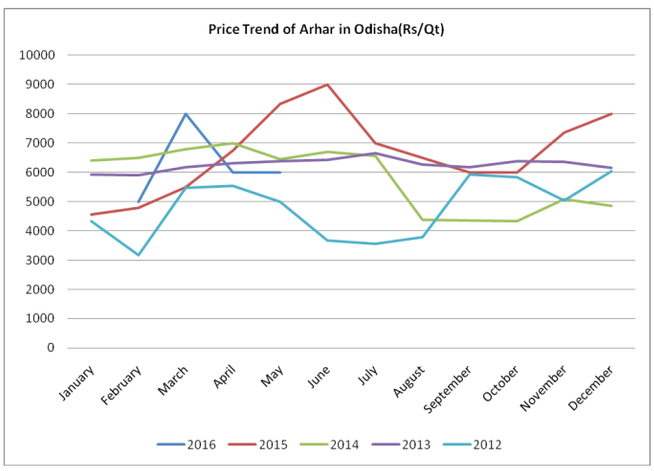


Figure 52: Price Trend of Arhar in Odisha

Source: http://agmarknet.gov.in

Marketing of Arhar and its products are affected by the climate risks like wet spell, flood and cyclone. Its impact and coping mechanism are described below.

Table 11: Climate risks, impact and coping mechanism of Arhar and its product during marketing stage

Climate Risk	Impact	Coping mechanism
Wet spell	Effect on product supply, selling and price, deterioration of quality	Preventing the stock from getting wet, planning based on weather forecast
Flood	Water logging, poor drainage, wastage of products, effect on power supply, effect on transportation, product supply and transaction	Draining of excess water from market yard, stores and counters, restoration of power supply through alternate arrangements, shifting of products to safer place
Cyclone	Effect on transportation and supply, damage/wastage of products meant for sale, effect on power supply and sale	Reorganising and restoring the marketing process

Woman members of the farm families are engaged in selling arhar in the local market/ haat.

4.5 Consumption

4.5.1 Mango

For consumption purpose, green mangoes, ripe mangoes and mango products like mango pickle, dry mango, mango bar, mango jam, mango drinks are available in the market. During harvesting season, green and ripe mangoes are flooded in the market and are consumed by all classes of consumers. Mango products are available round the year and are sold as per the requirement and taste of the consumers. As depicted from the figure 53, 40% of the consumers are purchasing green and ripe mango weekly during mango season while 55% of the consumers purchase mango and its products as and when required. Rest are not particular about the frequency of purchase. 55% of the consumers prefer to buy from local/retail shops while 25% buy from local market/mandi and 20% of the consumers depend on street vendors as mentioned in the fig 54.

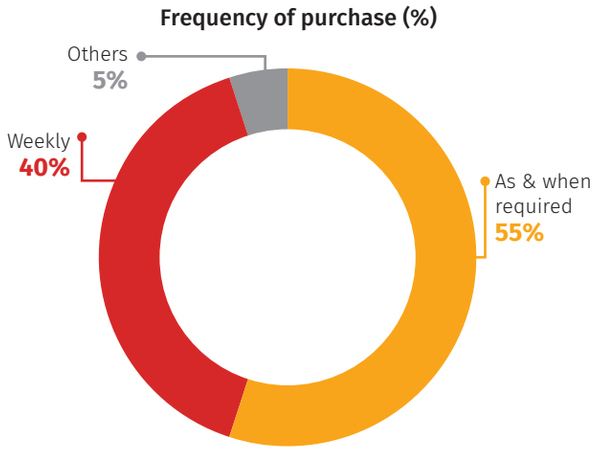


Figure 53: Frequency of purchase of mango

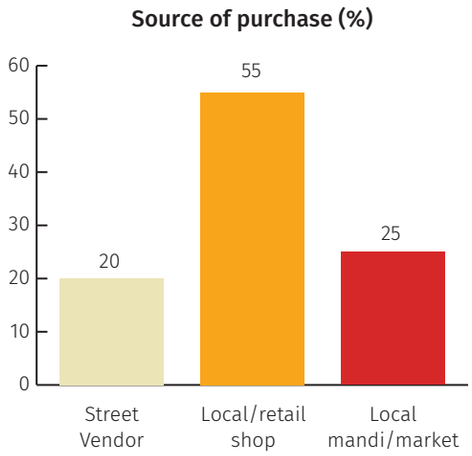


Figure 54: Source of purchase of mango

It is evident from the figure 55 that, while buying mango & its products, 40% of the consumers look for neat & cleanliness, 35% give emphasis to price while 25% give importance to quality of the product. Regarding price satisfaction of the commodity,60% of the consumers have medium level of satisfaction on price while 40% are highly satisfied with what they pay for the commodity as shown in figure 56.

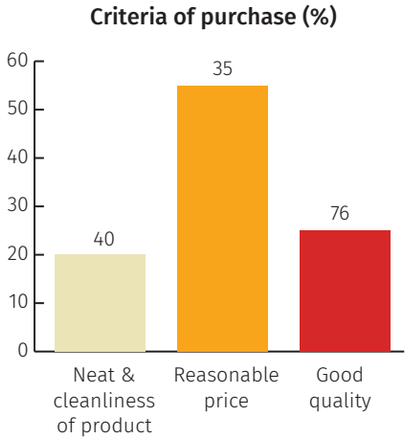


Figure 55: Criteria of purchase for mango

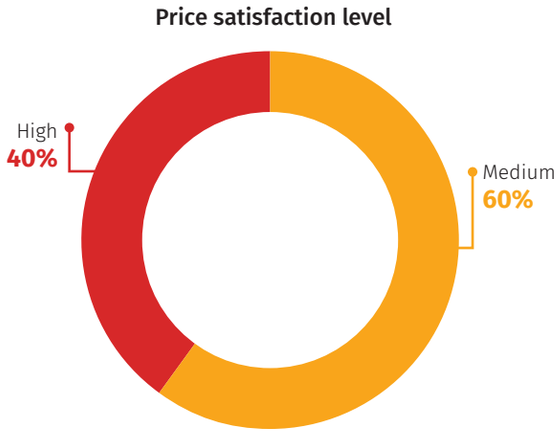


Figure 56: Price satisfaction level of mango consumer

The availability and supply of mango and its product in the market are affected by abnormal climatic conditions which affects the normal consumption pattern.

4.5.2 Arhar

Arhar is consumed as dal as well as whole grain. Regarding frequency of purchase by the consumers, study reveals that, 30% of the consumers prefer to buy on weekly basis to avoid storage nuisance, 20% each prefer to buy on fortnightly and monthly basis where as 30% of the consumers buy as and when required as shown in figure 57. Around 75% of the consumers prefer to buy from local/retail shops and 15% of the consumers buy from other sources like exhibition stalls, farmers, etc. 10% of the consumers purchase from local markets and street vendors as evident in the figure 58.

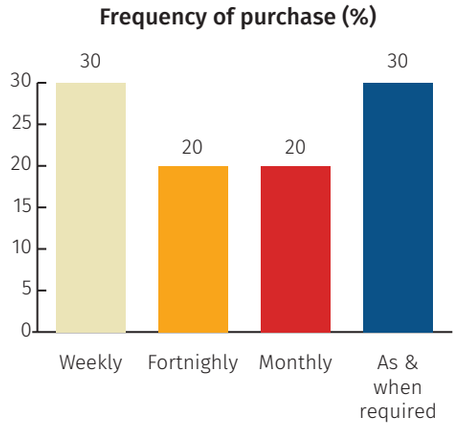


Figure 57: Frequency of purchase of Arhar

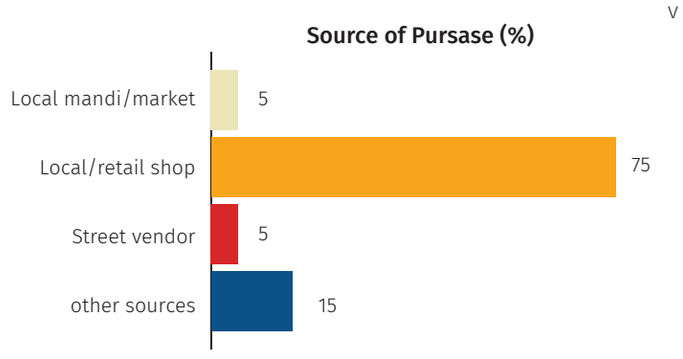


Figure 58: Source of Purchase of Arhar

While buying Arhar and Arhar products, 35% of the consumers give emphasis on price, 25% each look for quality and neat & cleanliness. 10% of the consumers look for accurate weight while 5% are particular on proper packing of the product as depicted in figure 59. Regarding price satisfaction, 55% of the consumers are highly satisfied with what they pay for the commodity while 45% of the consumers have medium level of satisfaction on price as observed in the figure 60.

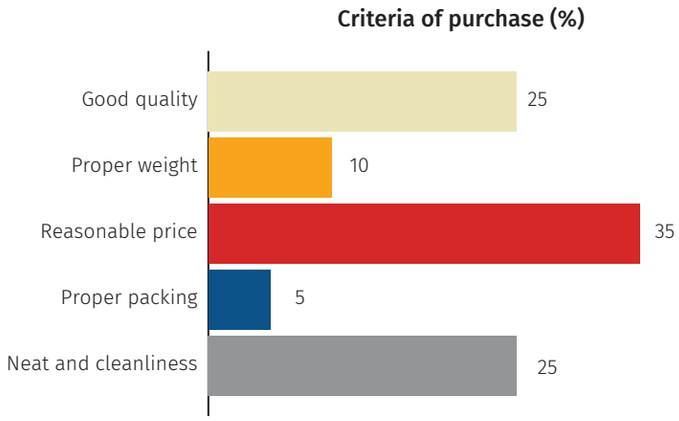


Figure 59: Criteria of purchase for Arhar

Figure 60: Price satisfaction level of Arhar consumers

The availability and supply of Arhar dal in the market are affected by abnormal climatic conditions which affects the normal consumption pattern. Many consumers shift to other pulses in case of short supply or non-availability of Arhar dal in the market.

SECTION 5:

Opportunities and Constraints

Opportunities and constraints for growth and development of Mango and Arhar in the state are elaborated below.

Table 12: Opportunities and constraints

Commodity	Opportunities	Constraints
Mango	· Increasing demand for mango and its processed products in the state · Suitable land and climate for mango cultivation · Scope of export of mango to neighbouring states and to foreign countries · Farmers are willing to take up commercial mango cultivation · Favourable Govt. policy and program for mango cultivation	· Uncertainty in weather conditions and frequent occurrence of natural calamities · Difficulty in accessing institutional finance · Lack of organised market mechanism · Lack of aggregation and pack house facility · Lack of cool chain facility · Lack of processing facility · Lack of insurance coverage
Arhar	· Regular demand for Arhar Dal by house hold consumers as well as institutional buyers in the state · State is yet to be self sufficient in Arhar production · Scope for extension of area · Suitable climate for Arhar cultivation · Favourable Govt. Policy and program for Pulses cultivation · Scope of export of Arhar (raw and processed) to neighbouring states · Most of the processing units are importing Arhar from other states to meet their requirement	· Lack of suitable short duration and high yielding variety · Lack of interest among farmers for Arhar cultivation · Traditional method of cultivation · Un remunerative return · Uncertainty in weather conditions and frequent occurrence of natural calamities · Lack of support for processing unit · Lack of institutional credit facility · Inadequate availability of farm labour · Lack of organised market mechanism

SECTION 6:

Key Recommendations

The opportunities and constraints highlighted in the preceding sections of this study has been analysed in detail to come out with key recommendations for climate proofing and strengthening the value chains for mango and arhar in a follow-up report on **"Operational Strategy for Climate Resilient Value Chain Development of Mango & Arhar in Odisha"**. For the complete operational strategy, it is requested to peruse the follow-up report. Some glimpses of the recommendations from the follow-up study is provided here.

6.1 Short Term-High Impact Priorities

- Provision of high yielding climate resilient planting materials of Mango and short duration high yielding varieties of climate resilient Arhar seeds at block level during planting/sowing season.
- Issue of soil health card to each and every farmer.
- Provision of institutional credit facility for Mango and Arhar cultivation.
- Organising training programs for farmers on climate resilient and sustainable agricultural practices of crop production, integrated nutrient management, integrated pest management, efficient water management, harvesting technique, post harvest management and safe storage techniques of Mango and Arhar synchronising with crop calendar.
- Provision of plant nutrients, plant protection materials, plant growth regulators, plant hormones for Mango and Arhar at production cluster/block level.
- Organising buyer-seller meet before and during harvesting of Mango and Arhar for interface of farmers/farmer groups with the traders, processors, exporters and institutional buyers.
- Mobile alert/message to the Mango and Arhar growers/farmers on crop, weather and market information.
- Encouragement/ motivation of Mango/Arhar farmers for adopting inter cropping, mixed cropping and integrated farming.
- Organising training programs for women SHGs and woman members of the farm families on preparation of processed products of Mango and Arhar.

6.2 Short Term-Low Impact Priorities

- Provision of crop insurance for Mango and Arhar cultivation.
- Provision of farm implements and equipments/ custom hiring centres at block level.

6.3 Long Term-High Impact Priorities

- Establishment of aggregation centre, pack house at production cluster/block level.
- Provision of small scale processing units at production cluster level.
- Establishment of storage structures/godowns for Arhar and cold storage/cold chain for Mango.
- Establishment of organised marketing mechanism for Mango and Arhar.
- Contract farming/buy back arrangement for Mango and Arhar with processing industries, exporters, institutional buyers, corporate retail stores like Reliance fresh, Big bazaar, Mother dairy, etc
- Linkage of pulses producer groups/organization with Mid-day meal program and Aahaar yojana.
- Establishment of marketing structure, mandi/hub for Mango and Arhar at production cluster/block level.
- Demonstration on scientific crop production, integrated nutrient management, integrated pest management, efficient water management, harvesting technique, post harvest management and processing of Mango and Arhar.
- Training and demonstration on canopy management for Mango farmers.
- Organising exposure visits for Mango and Arhar farmers.
- Establishment of weather forecasting unit at block level.
- Promotion of micro irrigation system (drip irrigation) in Mango orchards.
- Promotion and strengthening of Farmer Producer Organizations for value chain development of Mango and Arhar in the state.
- Provision of term loan and subsidy for establishment of aggregation centre cum pack house, processing unit, storage godown/ cold storage.
- Fixation of minimum support price for Arhar.
- Development of Mobile App for Mango and Arhar farmers.
- Establishment of soil testing laboratory at block level and provision of mobile soil testing services to farmers.
- Promotion of farm mechanization to reduce dependency on human labour.

Annexure

Annexure-1: List of Nurseries

	Name of the District	Name of the block	Name of the Nursery
1	Angul	**Angul**	Transit Nursery, Angul
2		**Angul**	Central Nursery, Panchamahla
3		**Kisore nagar**	Transit Nursery, Boinda
4		**Kisore nagar**	Transit Nursery, Bamur
5		**Athamallik**	Transit Nursery, Athamallik
6		**Chhendipada**	Block Level Nursery, Chendipada
7		**Pallahara**	Transit Nursery, Kanhia
8		**Talcher**	Transit Nursery, Talcher
9	Dhenkanal	**Dhenkanal**	Transit Nursery, Dhenkanal
10		**Kamakhyanagar**	Transit Nursery, K.nagar
11		**Kamakhyanagar**	Hort. Nursery, Jiridamali
12		**Parajang**	Block Level Nursery,Parajang
13		**Kankadahad**	Block Level Nursery, Kankadahad
14		**Hindol**	Block Level Nursery Hindol
15	Balasore	**Balasore**	Transit Nursery, Balasore
16		**Remuna**	Central Nursery, Balia
17		**Basta**	Transit Nursery, Paunskuli
18		**Bhogarai**	Central Nursery Jaleswarpur
19		**Jaleswar**	Transit Nursery, Jaleswar
20		**Soro**	Transit Nursery., Soro
21		**Nilagiri**	Transit Nursery, Nilagiri
22	Bhadrak	**Bhadrak**	Transit Nursery,Bhadrak
23		**Simulia**	Transit Nursery,Ranital
24		**Basudevpur**	Transit Nursery,Basudevpur
25		**Banth**	Transit Nursery, Ganijang, Bant
26		**Chandabali**	Transit Nursery, Chandabali
27		**Dhamnagar**	DRDA Nursery, Dhamnagar
28	Bolangir	**Bolangir**	Transit Nursery, Bolangir (Kusumkani)
29		**Gudvela**	Transit Nursery, Gudvella
30		**Loisinga**	Transit Nursery, Loisinga
31		**Muribahal**	Transit Nursery, Muribahal
32		**Tureikela**	Transit Nursery, Kurli
33		**Belpara**	Transit Nursery, Belapada
34		**Patnagarh**	Transit Nursery, Patnaagarh
35	Subarnapur	**Birmaharajpur**	Transit Nursery,Birmaharajpur
36		**Binka**	Block Level Nursery, Binika
37		**Tarabha**	Block Level Nursery Tarabha
38		**Dunguripalli**	Block Level Nursery Dunguripalli
39		**Ullunda**	Block Level Nursery Ullunda
40		**Dharmasala**	Dharmasala nursery
41	Cuttack	**Athagarh**	Transit Nursery, Athagarh
42		**Mahanga**	Transit Nursery Mahanga
43	Jagatsinghpur	**Jagatsinghpur**	Transit Nursery, Jagatsinghpur

	Name of the District	Name of the block	Name of the Nursery
44	Jajpur	**Jajpur**	Transit Nursery, Jajpur
45		**Rasulpur**	Block Level Nursery, Suansahi
46		**Dharmasala**	Transit Nursery, Anjira
47	Kendrapara	**Kendrapara**	Block Level Nursery, Kendrapara
48		**Aul**	Block Level Nursery, Aul
49		**Marshaghai**	Block Level Nursery, Marsaghai
50		**Mahakalpara**	Block Level Nursery, Mahakalpada
51		**Garadpur**	Block Level Nursery, Garadpur
52		**Pattamundai**	Block Level Nursery, Pattamundai
53		**Rajkanika**	Central Nursery, Rajkanika
54	Gajapati	**Goshani**	Transit Nursery, P.khemundi
55		**Rayagada**	Transit Nursery,Jeerango
56	Ganjam	**Patrapur**	Block Level Nursery Patrapur
57		**Hinjulikatu**	Block Level Nursery, Hinjulikatu
58		**Bhanjanagar**	Transit Nursery, Bhanjanagar
59		**Buguda**	Block Level Nursery,Thanapalli
60	Keonjhar	**Anandpur**	Transit Nursery, Salapada
61		**Anandpur**	Transit Nursery, Anandapur
62		**Ghasipura**	Block Level Nursery, Khalana
63		**Keonjhar**	Block Level Nursery, Bodapalasa
64		**Keonjhar**	Transit Nursery,Keonjhar (office)
65		**Ghatagaon**	Block Level Nursery, Dhenkikote
66		**Patna**	Block Level Nursery, Patna
67		**Saharpada**	Transit Nursery, Saharpada
68		**Harichandanpur**	Transit Nursery., Harichandanpur
69		**Jhumpura**	Block Level Nursery., Jhumpura
70		**Telkoi**	Block Level Nursery Telkoi
71	Sambalpur	**Dhankauda**	Transit Nursery, Sambalpur
72		**Dhankauda**	Transit Nursery, Burla
73		**Jujumora**	Nildunguri Nursery
74		**Rengali**	Block Level Nursery, Rengali
75		**Kuchinda**	Transit Nursery ,Kuchinda
76		**Rairakhol**	Transit Nursery,Rairakhol
77		**Nuasahi**	Transit Nursery, Nuasahi
78	Baragarh	**Atabira**	Transit Nursery,Gambharipali
79		**Bhatli**	Transit Nursery, Pipalmunda
80		**Padampur**	Transit Nursery Padampur
81	Jharsuguda	**Jharsuguda**	Central Nursery, Lahandabud
82		**Jharsuguda**	Transit Nursery,Jharusguda
83		**Jharsuguda**	Block Level Nursery, Badmal
84		**Jharsuguda**	Block Level Nursery, Koilaga
85		**Lakhanpur**	Block Level Nursery, Banjari
86		**Lakhanpur**	Block Level Nursery, Rengali
87		**Lakhanpur**	Block Level Nursery, Junion
88		**Lakhanpur**	Block Level Nursery,Bhikampali

	Name of the District	Name of the block	Name of the Nursery
89		**Kolabira**	Block Level Nursery, Sanyasipali
90		**Kolabira**	Block Level Nursery, Siriapali
91		**Kirimira**	Block Level Nursery,Kirimira
92		**Kirimira**	Block Level Nursery,Jharmunda
93		**Laikera**	Block Level Nursery, Kuleimura
94		**Laikera**	Block Level Nursery, Bhatalaida
95		**Koraput**	Block Level Nursery, Kolab
96		**Semiliguda**	Transit Nursery, Sunabeda
97		**Baipariguda**	Transit Nursery, Chandrapada
98	Koraput	**Jeypore**	Transit Nursery, Jeypore
99		**Boriguma**	Transit Nursery, Kundraguda
100		**Kundra**	Transit Nursery, Kundra
101		**Kotpav**	Transit Nursery, Kuhudigaon
102		**Rayagada**	Transit Nursery, Rayagada
103		**Gunupur**	Transit Nursery,Gunpur
104	Rayagada	**Gunupur**	Central Nursery,Gunpur
105		**Gunupur**	DRDA Nursery,Gunpur
106		**Gudari**	Transit Nursery. Gudari
107		**Muniguda**	Block Level Nursery, Muniguda
108		**Nawarangpur**	Transit Nursery, Nuagada
109		**Nawarangpur**	Cashew nursery
110		**Dabugaon**	Transit Nursery, Dabugaon
111		**Jharigaon**	Block Level Nursery, Jharigaon
112	Nawarangpur	**Chandahandi**	Block Level Nursery Chandahandi
113		**Nandahandi**	Block Level Nursery ,Nandahandi
114		**Raighar**	Block Level Nursery ,Raighar
115		**Tentulikhunti**	Block Level Nursery ,Tentulikhunti
116		**Papdahandi**	Block Level Nursery, Papdahandi
117		**Malkanagiri**	Transit Nursery, Malkangiri
118		**Malkanagiri**	Block Level Nursery, Malkangiri
119	Malkangiri	**Korkunda**	Block Level Nursery, Korkunda
120		**Kalimela**	Block Level Nursery, Kalimela
121		**Mathili**	Block Level Nursery, Mathili
122		**Khajuriapada**	Transit Nursery, Pilasalki
123		**Phulbani**	Transit Nursery, Phulbani
124		**Raikia**	Block Level Nursery, Ramamunda, Raikia
125	Kandhamal	**Tikabali**	Block Level Nursery, Bilabeda
126		**Chakapada**	Block Level Nursery, Kendugudari
127		**Darigbadi**	Transit Nursery Daringbadi
128		**Baliguda**	Transit Nursery, Goibali

	Name of the District	Name of the block	Name of the Nursery
129		**Udala**	Transit Nursery,Jagannathi
130		**Rairangpur**	Transit Nursery, Rairangpur
131	Mayurbhanj	**Karanjia**	Transit Nursery, Karanjia
132		**Baripada**	District Nursery, Baripada
133		**Jasipur**	Transit Nursery, Jasipur
134		**Komna**	Block Level Nursery, Komana
135		**Nuapara**	Block Level Nursery, Nuapara
136	Nuapara	**Sinapali**	Block Level Nursery, Sinapalli
137		**Boden**	Block Level Nursery, Boden
138		**Khariar**	Transit Nursery Tarbod
139		**Khariar**	Transit Nursery,Khariar
140		**Lanjigarh**	Block Level Nursery, Dhanarbhat (BiswaNath Pur)
141		**BhawanipaTransit Nurserya**	Transit Nursery,BhawanipaTransit Nurserya
142		**Kesinga**	Block Level Nursery,Chirchirla
143		**Narla**	Block Level Nursery,Beherapati
144	Kalahandi	**Karlamunda**	Block Level Nursery, Karlamunda
145		**Junagarh**	Block Level Nursery, Junagarh(Ghumerguda)
146		**Golamunda**	Block Level Nursery,Golamunda
147		**Dharamgarh**	Central Nursery, Kebidi
148		**Koksara**	Block Level Nursery, Koksara
149		**Nayagarh**	Transit Nursery, Panipoila
150		**Nayagarh**	Transit Nursery, Nayagarh
151	Nayagarh	**Odagaon**	Block Level Nursery, Hariharpur
152		**Nuagon**	Block Level Nursery Nuagon
153		**Gania**	Block Level Nursery Gania
154		**Kakatpur**	Transit Nursery., Kakatpur
155		**Nimapara**	Transit Nursery, Nimapara
156	Puri	**Gop**	Transit Nursery.,Gop
157		**Baliguali**	Transit Nursery Baliguali
158		**Astaranga**	Transit Nursery. Astaranga
159	Khurda	**Khurda**	Orchard, SOH, khurda
160	Boudh	**Kantamal**	Block Level Nursery, Kantamal
161		**Harabhanga**	Block Level Nursery, Harabhanga

Source: Directorate of Horticulture, Odisha

Annexure-2: Mango Graft Production (2017-18)

Sl. No.	Name of the District	Departmental Farm/Nursery			Regd. Private Nursery		
		Accredited	Non-Accredited	Total	Accredited	Non-Accredited	Total
1	Balasore		11741	11741			0
2	Bhadrak		29968	29968			0
3	Bolangir	37500	81000	118500	136832	14500	151332
4	Sonepur	40000	20000	60000	49500		49500
5	Cuttack	30000		30000	369240	42670	411910
6	Jagatsinghpur		32005	32005			0
7	Jajpur		50000	50000	8000	14000	22000
8	Kendrapada		5155	5155			0
9	Angul	310013	75000	385013	74000	6500	80500
10	Dhenkanal	100000	29684	129684	509000	103500	612500
11	Gajapati	30000	32500	62500			0
12	Ganjam	20000	3500	23500			0
13	Keonjhar	101460	23190	124650	23000		23000
14	Kalahandi	78979	20309	99288			0
15	Nuapada	76550	80716	157266			0
16	Kandhamal	40615	75000	115615	1000	1600	2600
17	Boudh		51000	51000			0
18	Koraput	105982	114000	219982	20000		20000
19	Rayagada	110250		110250	272000		272000
20	Nabarangpur		66000	66000			0
21	Malkangiri		119158	119158			0
22	Mayurbhanj		227549	227549	60000		60000
23	Khurda	123921	30230	154151			0
24	Puri	2126		2126			0
25	Nayagarh	12000		12000	2000		2000
26	Sambalpur	106680	27000	133680	160700		160700
27	Deogarh	101600		101600	5000	8500	13500
28	Bargarh	35000		35000	10000		10000
29	Jharsuguda		87300	87300		19000	19000
30	Sundargarh	89650	29600	119250		5000	5000
	Total	1552326	1321605	2873931	1700272	215270	1915542

Varieties: Amrapalli, Baiganpalli,Keshar,Neelam

Source: Directorate of Horticulture, Odisha

Annexure-3: District wise Numbers of Fertilizer Dealers in Odisha

Sl.No	Name of the District	No. of Wholesale Dealer	No. of Retail Dealer
1	Balasore	32	799
2	Bhadrak	24	645
3	Bolangir	23	817
4	Sonepur	10	342
5	Cuttack	54	526
6	Jagatsinghpur	30	307
7	Jajpur	24	492
8	Kendrapada	19	368
9	Angul	20	292
10	Dhenkanal	22	341
11	Gajapati	11	111
12	Ganjam	52	753
13	Keonjhar	21	514
14	Kalahandi	38	788
15	Nuapada	10	262
16	Kandhamal	7	73
17	Boudh	5	262
18	Koraput	20	213
19	Rayagada	17	144
20	Nowrangpur	26	296
21	Malkangiri	8	94
22	Mayurbhanj	31	685
23	Khurda	29	336
24	Puri	43	595
25	Nayagarh	20	306
26	Sambalpur	24	184
27	Deogarh	5	115
28	Bargarh	63	503
29	Jharsuguda	6	95
30	Sundargarh	14	258

Source: www.agrisnetodisha.ori.nic.in

Annexure-4: District wise Numbers of Pesticide Dealers in Odisha

Sl. No.	Name of the District	No. of Pesticide Dealer
1	Angul	32
2	Balasore	168
3	Bargarh	536
4	Bhadrak	54
5	Bolangir	106
6	Boudh	37
7	Cuttack	174
8	Deogarh	18
9	Dhenkanal	28
10	Gajapati	11
11	Ganjam	151
12	Jagatsinghpur	44
13	Jajpur	73
14	Jharsuguda	34
15	Kalahandi	178
16	Kendrpada	39
17	Keonjhar	54
18	Khordha	125
19	Koraput	74
20	Mayurbhnj	79
21	Malkangiri	28
22	Nabarangpur	63
23	Nayagarh	52
24	Nuapada	55
25	Phulbani	17
26	Puri	192
27	Rayagada	82
28	Sambalpur	109
29	Sonepur	127
30	Sundargarh	63

Source: www.agrisnetodisha.ori.nic.in

Action on Climate Today (ACT)
For more information,
Email: info@actiononclimate.today
www.actiononclimate.today

ACT CCIP
ACTION ON CLIMATE TODAY

Department of
Agriculture and
Farmers' Empowerment,
Government of Odisha