TRANSFORMATION OF AGRICULTURE THROUGH CROP PRIORITIZATION

(A strategy document for 2022-2027)

Department of Agriculture
Ministry of Agriculture and Forests
Thimphu : Bhutan

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Published by:

Department of Agriculture
Ministry of Agriculture and Forests
Thimphu, Bhutan
Tel# 02-322228 / 331316

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སོ་ནམ་དང་ནགས་ཚལ་ལྷན་ཐག།
ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture and Forests
Thimphu : Bhutan

FOREWORD

The Ministry of Agriculture and Forests is pleased to publish this strategy document which is expected to bring about an impactful agriculture development for a sustainable food system and economic wellbeing of the country. Crop prioritization is one of the mechanisms to formulate structured implementation of the agriculture development initiatives through re-organizing investment priorities to realize national needs. Such strategy is required to position agriculture sector as one of the key drivers for economic development, making farming as one of the competitive economic activities through paradigm shift from subsistence agriculture to agriculture as a commercial business venture.

Through rigorous exercise by the team from the Department of Agriculture and the Department of Agricultural Marketing and Cooperatives, fifteen crops that contribute to food and nutrition security and seventeen crops that has potential to generate income through export have been identified. The prioritized crops for food and nutrition security include rice, wheat, maize, potato, chilli, onion, tomato, beans, cauliflower, citrus, banana, mango, apple, rajma bean and red lentils while the prioritized crops identified for export markets are citrus, apple, potato, cardamom, ginger, buckwheat, quinoa, mushroom, asparagus, pineapple, avocado, kiwi, dragonfruit, almond, strawberry, turmeric and adzuki beans. The focus of the Ministry shall be on the production of these commcodities on commercial scale to optimize economies of scale through supporting farm development, farm mechanization, irrigation infrastructures and input supplies. However, this strategy will not limit the liberty of our farmers to cultivate their preferred choice of crops.

The strategy document is a result of rigorous consultation with the different stakeholders and the Ministry commends the team for their efforts. With the adoption of this strategy, the Ministry calls on all the agencies and stakeholders involved for their commitment in implementing and realizing its objectives. At the same time the Ministry will continue to solicit support and put in conscious efforts to help further and sustain agriculture sector development through investing in priority crops.

Tashi Delek

(Thinley Namgyel)
SECRETARY

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1 Introduction

A careful analysis of the current state of government investment across a wide range of crops indicates that the technical inputs and limited resources are thinly spread out among many commodities which could be the main reason for not being able to yield the desired and much-needed output. The subsidies and incentive schemes are also found to be spread across many commodities, while such a noble initiative may not necessarily be achieving its core objectives. In the context of declining resource allocation for the agriculture sector, it is of paramount importance to prioritize our investment for a few crops that have significant contribution towards national food and nutritional security, employment and income generation potentials. While all the crops are important to the farmers from their own perspectives, it may not necessarily be important from the perspective of national food and nutrition security. In view of the emerging issues such as the pandemic, socio-economic preferences, climate crisis, youth unemployment challenges and limited resources, it is only prudent that we prioritize crops for food and nutrition security and also for export markets.

Further, there is also no clarity as to what constitutes food security and how the national food security is to be pursued. This strategy, therefore, guides what crops to be prioritized for food security and crops that have potential for export. The crops that are economically not feasible can be imported but the import value should be offset by export value earned by upscaling the production of the identified export potential crops.

2 Rationale

In the pursuit of food and nutrition security, the Ministry of Agriculture and Forests is promoting more than 40 different commodities, wherein scarce resources are thinly spread across many commodities. Likewise, subsidies or incentives for crops are also spread across a large number of commodities.

Although 49.9% of the total employed population depends on agriculture sector (NSB, 2020), the scale of production is still small and the production sites are scattered. The share of annual budget allocation to crop sector has also decreased over the years due to which a sluggish growth is observed in the sector. The other reasons for the slow growth could be due to virtual collapse of prioritization system and, more importantly due to the non-existence of focused development approaches.

Therefore, to revive, re-vitalize and sustain agriculture sector growth in Bhutan, the sector should gear towards paradigm shift from subsistence agriculture to agriculture as a business that is profitable and commercial-oriented. A new strategy is needed to position agricultural sector as one of the key drivers for economic development and make farming one of the competitive economic activities. One of the policy options could be adopting crop prioritization strategy.

The crop prioritization is expected to increase the scale of production and reduce the investment costs. This will also guide the field colleagues to implement the agriculture development programs through focused investment approaches. The strategy clearly details out investment focus, strategic thrusts and the various interventions that the ministry will undertake to propel and upscale agriculture sector development. This strategy will guide to revitalize agriculture sector through proposing a realistic focus of investments necessary for up-scaling agriculture production through establishment of commercial farms, and revival of 65,922 acres (RSD, 2019) of fallow land.

3 Objectives

The core of objectives of this strategy document is:

a. To focus resource allocation on priority commodities and bring about impactful change in food and nutrition security
b. To reduce the cost of production through up-scaling crop production and establishment of commercial farms
c. To incentivize production of priority commodities and promote efficient and effective marketing system.

4 Methodology

4.1 Crop listing

The crops were listed for analysis based on the past policy documents. Then the crops were categorized into different commodity groups such as cereals, vegetables, fruits and nuts, pulses, and spices.

4.2 Prioritization criteria

In order to make crop prioritization comprehensive and inclusive, five broad selection criteria were used as follows:

i. ***Production potential:*** Production potential is the technical feasibility to grow crops in a particular Dzongkhag/agro-ecological zone provided the availability of all the inputs such as seeds, nutrients, labour, machinery, etc.

ii. ***Commercial Potential:*** Opportunity/potential to produce on large scale including enterprise development in that particular crop sector, value addition, processing, creation of employment opportunities and generation of revenue.

iii. ***Average production:*** An average production figure in MT from 2018 to 2020.

iv. ***Export value:*** An average export value in Ngultrum from 2018 to 2020.

v. ***Import value:*** An average import value in Ngultrum from 2018 to 2020.

4.3 Data collection and source

Both primary as well as the secondary data were used. The primary data were collected from 60 technical experts from different agencies under the Department of Agriculture and the Department of Agricultural Marketing and Cooperatives (DAMC) using a structured questionnaire. The expert opinions on the importance of each commodity against five criteria at Dzongkhag and National level were collected.

The documents such as the 12th FYP document, RNR Strategy 2030, RNR Marketing Strategy 2021, Incentive Scheme Price 2021, Commodity Research and Development Strategies, Agriculture Statistics, and Bhutan Trade Statistics were used as a source of secondary data. An average of the past three years (2018-2020) was used for analysis.Several consultation meetings and workshops were conducted with the different stakeholders including the technical experts from different agencies under the DoA and DAMC to validate data.

4.4 Data analysis

In this exercise, we have used the simple method of Multi-Criteria Decision-Making Tools called Simple Additive Weighting (SAW). This method is widely used, simple and its application ranges from investment prioritization, site selection for important infrastructure, selection of employees, etc.

The data collected from primary and secondary sources were cleaned, segregated, and analyzed using general purpose programming language (Python version 3.10) and Microsoft Excel. The Weighted Sum Model (WSM) or Simple Additive Weighting (SAW) from the Multi-Criteria Decision Analysis (MCDA) tool was used for crop prioritization. Firstly, the raw data were arranged into a tabular format called pairwise comparison matrix or decision matrix (Annexure

1) with all the commodities in one column and criteria with their values in the rest of the columns. As the raw scores were measured in different scales and units, it was normalized using linear min-max normalization formula (i) generating a new matrix called normalized decision matrix (Annexure 2). The normalized scores for each of the criteria were then multiplied by its respective weightage to generate a weighted normalized decision matrix (Annexure 3). The weightage for the criteria were calculated using Analytical Hierarchical Process (Annexure 5). The values in the weighted normalized decision matrix were then summed to calculate the preference scores for respective crops within each of the commodity categories (Annexure 4). Finally, the crops were grouped into different commodities and then ranked in descending order of their performance scores (Annexure 4).

$$n = \frac{r - r_{min}}{r_{max} - r_{min}} \ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Where,

n is the normalized values

r is the non-normalized value

r_{min}*is the minimum value of non-normalized value*

r_{max} *is the maximum value of the non-normalized value*

5 Results and Discussion

5.1 Priority Crops for Food and Nutrition Security

Based on the priority ranking matrix, 15 crops were identified for Food and Nutrition Security which are essential for consumption that will provide the daily dietary energy requirement of 2200 Kcal/day per person (recommended by WHO). The additional nutrients such as vitamins, minerals and proteins would be available from dairy products and other fruits and vegetables. The prioritized crops are ranked in order of higher scores and grouped into different commodities such as cereals, vegetables, fruits and pulses as shown in Table 1.

Table 1. Prioritized crops for Food and Nutritional Security

Commodity	Crops	Per capita availability (g/day)	Total energy contents (Kcal/day)
Cereals	Rice	412	1481
	Wheat	44	160
	Maize	110	390

Vegetables	Potato	71	47
	Chilli	39	10
	Onion	13	3
	Tomato	11	2
	Beans	11	5
	Cauliflower	7	1
Fruits	Citrus	72	38
	Banana	12	7
	Mango	4	2
	Apple	14	7
Pulses	Rajma bean	3	11
	Lentil	7	25
Total		**830 g/day**	**2189 Kcal/day**

5.2 Priority crops identified for Export

A total of 17 crops were prioritized for export markets including 5 existing export crops and 12 potential export crops which have future potential to generate significant revenue (Figure 1). The revenue generated from export commodities will be used for importing other crops required for food and nutrition security if not sufficiently produced in the country. This will contribute towards narrowing down the negative trade balance. Although there are some revenues being generated from the export of chillies, beans, tomatoes, cauliflowers, soyabeans, and rajma beans, the contribution to the national income is insignificant.

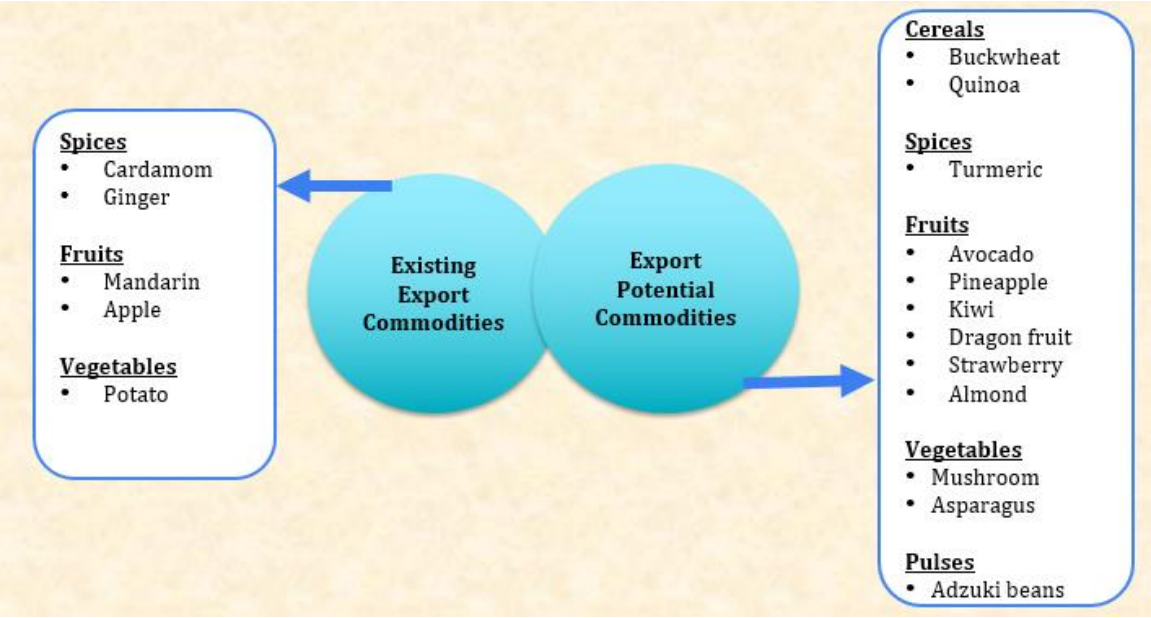

Figure 1: Priority crops for export

5.3 Total requirement, total production and deficit of priority crops for food and nutrition security

The total average production of the priority crops for food and nutrition security is approximately 199,473 MT against the total annual requirement of 218,239 MT. The deficit volume is about 120,005 MT which is worth of Nu. 3,514 million. In terms of potato, maize and beans, the total production exceeds the total requirement, thus the import volume is indicated as deficit quantities as the import of these crops are required during the lean season for consumption.

Table 2. Total Production Requirement, Volume and Value of Deficit Production

Commodity	Crops	Requirement (MT)	Production (MT)	Deficit (MT)	Deficit Value (Nu. in million)
Cereals	Rice	118,914	55,975	62,951	1,814
	Wheat	12,677	1,462	12,180	294
	Maize	31,684	47,486	19,901	318
Vegetables	Potato	18,621	44,446	4,726	74
	Chilli	11,406	8,555	2,896	125
	Onion	3,641	225	3,416	91
	Tomato	3,161	284	2,880	73
	Beans	3,112	3,617	321	9
	Cauliflower	2,008	1,773	248	4
Fruits	Citrus	20,916	26,572	5,799	374
	Banana	3,592	3,222	370	8
	Mango	1,292	778	513	26
	Apple	4,069	4,020	1,541	168
Pulses	Rajma bean	933	772	166	10
	Lentil	2,081	284	2,097	127
Total		**23,8107**	**199,473**	**120,005**	**3,514**

5.4 Total revenue generation from existing export crops

There are about six existing export crops which contributes significantly towards revenue generation (Table 3). In total, Bhutan exports about Nu. 2,004 million worth with cardamom being the highest contributor (Nu. 837 million).

Table 3: Revenue from existing export crops

Category	Crop	Export volume (MT)	Export value (Nu. in million)
Fruits	Citrus	11,455	393
	Areca nut	6,038	125
	Apple	1,493	41
Spices	Cardamom	1,627	837
	Ginger	2,840	85
Vegetable	Potato	23,732	522
Total		**47,184**	**2004**

5.5 Trade balance

While assessing the value of import and export of crops, there is a negative trade balance of Nu. 1511 million. This significant negative trade balance indicates not only the requirement to enhance production of crops identified for food and nutrition security, but also the export commodities to generate revenue.

Table 4: Agriculture trade balance

Market	Commodity	Crops	Values (Nu. in million)
Export	Fruits	Citrus	393
		Areca nut	125
		Apple	41
	Spices	Cardamom	837
		Ginger	85
	Vegetable	Potato	522
	Total export values		**2004**
Import	Cereals	Rice	1,814
		Wheat	294
		Maize	318
	Vegetables	Potato	74
		Chilli	125
		Onion	91
		Tomato	73
		Beans	9
		Cauliflower	4
	Fruits	Citrus	374
		Banana	8

		Mango	26
		Apple	168
	Pulses	Rajma bean	10
		Lentil	127
	Total Import values		**3,514**
Trade Balance (Nu.)			**-1511**

Other crops which are excluded from the priority list shall be taken up by farmers without requiring much intervention from the government.

6 Recommended Strategies

Up-scaling production of commodities identified for food and nutrition security will contribute towards import substitution while up-scaling the production of commodities identified for export will increase revenue generation. In both the cases, there is a huge opportunity to stabilize trade balance through focused investment and interventions on priority crops. The The following recommendations and implementation strategies are proposed:

6.1 Strategy 1: Increase the scale of production of prioritized export crops to generate revenue. The support from the government should focus on production of these crops on large scale to meet the export volume requirement and enhance revenue generation.

6.2 Strategy 2: Enhance production of prioritized crops identified for food and nutrition security to reduce import and provide adequate dietary requirements. Production of crops on large scale should be encouraged and the support from the government should focus on the establishment of large commercial farms with all the modern amenities to attract youth.

6.3 Implementation Actions / Interventions

i. **Agricultural land development and land-use master-plan**

- New land development to increase area for crop production
- Terrace consolidation for easy mechanization
- Reversion and revival of fallow and degraded lands

ii. **Expanding and intensifying Irrigation**

- Smart and automated irrigation systems to improve water use efficiency.
- New irrigation systems in reverted fallow lands to improve crop productivity.

- Investments in water harvesting technologies and creation of artificial lakes
- Use of drones/precision agriculture.
- Innovation of solar pumps/zero energy pumps

iii. **Crop protection and human-wildlife management**

- Innovation of automatic animal repellent to reduce human-wildlife conflict
- Development of effective Bio-pesticides and bio-acoustics.
- Subsidies for e-fencing, solar fencing, chain link fencing etc.
- Technical advisory services on integrated pest and disease management

iv. **Investments in generation of research technologies**

- Innovation of precision Agricultural technologies
- Pests and disease forecasting mechanisms
- Development of climate smart crop varieties
- Development of mechanization and labor-saving equipment
- Development of high-yielding crop varieties
- Establishment of e-platforms for virtual marketing of agricultural produces
- Innovation of one-click crop monitoring system
- Smart irrigation/automated irrigation system
- Research of nutrient dense and export potential crops

v. **Other agricultural subsidies and input support**

- Establishment of mega greenhouse structures
- High-end protected cultivation structures for high value crop production
- High-yielding priority crop varieties
- Establishment of large scale commercial farms
- Landscape approach production of priority crops

vi. **Market Development and facilitation**

- Critical market infrastructures for priority crop market facilitation
- Establishment of mega cold store facilities and warehouses at strategic locations
- Establishment of market linkages/strengthening the market players
- Processing and value addition infrastructure development
- Product development for airfreight and high-end markets
- Postharvest management facilitation for priority commodities.

vii. **Skilling and capacity development program**

- Smart and Precision Agriculture
- Farm mechanization and machine development
- Processing and value addition of agricultural produces
- Other evolving technologies in Agriculture

7 Crop Prioritization Governance

i. The Ministry of Agriculture shall provide policy guidance and strategic direction on the implementation of this strategy document.

ii. The Department of Agriculture shall lead the implementation of this strategy document.

iii. The Dzongkhags shall prioritize specific potential crops prevalent in their repective dzongkhag from the nationally prioritized list of crops.

iv. While the farmers will have freedom to grow crops of their own choice and preferences, the Department of Agriculture shall provide packaged support to produce only the priority commodities on commercial scale.

v. The Ministry shall implement the production of priority crops on large scale following two pronged approaches:

- The Department of Agriculture shall identify potential farmers/agri-entrepreneurs/youths/groups/cooperatives who are willing to establish commercial farms.
- The government can assign the establishment of commercial farms to the State-Owned Enterprises (eg. FMCL) which will be ultimately handed over to the interested youths/youth groups.

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Annexure

Annexure 1: Multiple Comparison Matrix/Decision Matrix

Crops	Commercial Potential	Production Potential	Average Production (MT)	Import Value (Nu. in million)	Export Value (Nu. in million)
Buckwheat	4.5	4.3	2170.5	2.8	0.4
Maize	4.5	4.6	50747	13.4	0
Millet	3.8	4.1	1156	0	0
Quinoa	3.9	3.5	206	0	0
Rice	4.3	4.4	63890	1999.9	0.2
Wheat	4	4.3	1382	263.8	21.9
Apple	3.8	3.3	4020.5	13.5	61.6
Avocado	4.5	4.2	111.8	0	0
Banana	4.4	4.2	3221.8	11.6	0
Citrus	4.6	4.6	26572.4	5.7	454.4
Dragon fruit	3.3	3.2	0	0	0
Kiwi	3.9	3.1	0	0	0
Mango	4.2	4	777.7	19.9	0
Passion fruit	3.9	3.9	0	0	0
Pear	3.8	4.2	1354.2	0	0
Persimmon	3.4	3.5	216.1	0	0
Walnut	3.6	3.8	232.7	0	0
Adzuki bean	3.3	3	0	0	0
Chickpea	2.7	2.8	0	0	0
Groundnut	3.8	3.8	0	0	0
Lentils	3.9	3.4	94.7	0	0
Mung bean	3.7	3.6	0	0	0
Rajma bean	4.2	3.9	505.3	0	0
Soya bean	3.9	3.8	170.7	0.1	0.6
Soya bean	4.5	4.5	170.7	0.1	0.6
Black pepper	3	3.2	0	0	0
Cardamom	4.5	4.3	1477.5	0.5	1162.4
Ginger	4.8	4.5	5234.5	0	79.2
Herbs and MAPs	3	3	0	0	0
Turmeric	4.7	4.4	46	2.3	0
Mustard	4.5	4.2	392	0.3	0.1
Pyrilla	4	3.3	0	0	0
Sunflower	4.4	3.8	0	0	0

Sugarcane	4	4	0	0	0
Tea	4	2	0	82.8	0
Areca nut	4.1	3.2	15077.8	2.5	57.5
Coffee	3.7	3	0	0	0
Hazelnut	3.6	3.5	3.9	0	0
Sunflower	1	1	0	0	0
Button mushroom	2	1	0	4.5	0
Oyster	2	2	112.25	2	0
Shiitake	3.4	2	117.21	0	0
Beans	4	4	2788.7	0	0.8
Bitter gourd	3	3	0	0	0
Brinjal	3.1	3.5	324.7	10.9	0
Broccoli	3.6	4	1145.7	0.2	0.2
Cabbage	2	2	5978.3	13	16.5
Carrot	2.7	2.5	1314.3	3.9	19.5
Cauliflower	3.7	4	1695	0.2	0.4
Chilli	4.4	4.7	8046.3	38.9	1.3
Garlic	3.6	3.4	655.5	3.4	0
Green leaves	3.3	4.2	1856.9	0.1	0
Onion	3.8	3.5	225.3	81.2	0
Potato	4.6	4.3	44446	58.1	496.9
Radish	3.3	4	4534.7	0	0
Tomato	3.8	3.7	284.3	59.7	0

Annexure 2: Normalized Decision Matrix

Crops	**N_Commercial Potential**	**N_Production Potential**	**N_Average Production**	**N_Import Value**	**N_Export Value**
Buckwheat	0.92	0.91	0.03	0	0
Maize	0.93	1	0.79	0.01	0
Millet	0.76	0.85	0.02	0	0
Quinoa	0.78	0.69	0	0	0
Rice	0.88	0.93	1	1	0
Wheat	0.8	0.9	0.02	0.13	0.02
Apple	0.73	0.62	0.06	0.01	0.05
Avocado	0.95	0.87	0	0	0
Banana	0.9	0.88	0.05	0.01	0
Citrus	0.97	0.98	0.42	0	0.39

Dragon fruit	0.62	0.59	0	0	0
Kiwi	0.76	0.59	0	0	0
Mango	0.85	0.82	0.01	0.01	0
Passion fruit	0.77	0.79	0	0	0
Pear	0.75	0.88	0.02	0	0
Persimmon	0.63	0.69	0	0	0
Walnut	0.69	0.75	0	0	0
Adzuki bean	0.62	0.55	0	0	0
Chickpea	0.44	0.5	0	0	0
Groundnut	0.74	0.76	0	0	0
Lentils	0.76	0.67	0	0	0
Mung bean	0.72	0.71	0	0	0
Rajma bean	0.84	0.8	0.01	0	0
Soya bean	0.77	0.75	0	0	0
Soya bean	0.93	0.96	0	0	0
Black pepper	0.53	0.6	0	0	0
Cardamom	0.93	0.91	0.02	0	1
Ginger	1	0.96	0.08	0	0.07
Herbs and MAPs	0.53	0.55	0	0	0
Turmeric	0.98	0.94	0	0	0
Mustard	0.92	0.88	0.01	0	0
Pyrilla	0.8	0.64	0	0	0
Sunflower	0.91	0.77	0	0	0
Sugarcane	0.8	0.82	0	0	0
Tea	0.8	0.27	0	0.04	0
Areca nut	0.83	0.61	0.24	0	0.05
Coffee	0.71	0.55	0	0	0
Hazelnut	0.7	0.69	0	0	0
Sunflower	0	0	0	0	0
Button mushroom	0.27	0	0	0	0
Oyster	0.27	0.27	0	0	0
Shiitake	0.64	0.27	0	0	0
Beans	0.8	0.82	0.04	0	0
Bitter gourd	0.54	0.55	0	0	0
Brinjal	0.56	0.68	0.01	0.01	0
Broccoli	0.68	0.82	0.02	0	0
Cabbage	0.27	0.27	0.09	0.01	0.01
Carrot	0.46	0.42	0.02	0	0.02
Cauliflower	0.71	0.82	0.03	0	0

Chilli	0.91	1	0.13	0.02	0
Garlic	0.7	0.66	0.01	0	0
Green leaves	0.61	0.87	0.03	0	0
Onion	0.74	0.68	0	0.04	0
Potato	0.95	0.9	0.7	0.03	0.43
Radish	0.61	0.82	0.07	0	0
Tomato	0.74	0.74	0	0.03	0

Annexure 3: Weighted Normalized Decision Matrix

Crops	**Commercial Potential**	**Production Potential**	**Average Production**	**Export Value**	**Import Value**
Buckwheat	0.12	0.13	0	0	0
Maize	0.12	0.14	0.06	0	0
Millet	0.1	0.12	0	0	0
Quinoa	0.1	0.1	0	0	0
Rice	0.11	0.13	0.08	0	0.35
Wheat	0.1	0.13	0	0.01	0.05
Apple	0.1	0.09	0.01	0.02	0
Avocado	0.12	0.12	0	0	0
Banana	0.12	0.12	0	0	0
Citrus	0.13	0.14	0.03	0.12	0
Dragon fruit	0.08	0.08	0	0	0
Kiwi	0.1	0.08	0	0	0
Mango	0.11	0.12	0	0	0
Passion fruit	0.1	0.11	0	0	0
Pear	0.1	0.12	0	0	0
Persimmon	0.08	0.1	0	0	0
Walnut	0.09	0.11	0	0	0
Adzuki bean	0.08	0.08	0	0	0
Chickpea	0.06	0.07	0	0	0
Groundnut	0.1	0.11	0	0	0
Lentils	0.1	0.09	0	0	0
Mung bean	0.09	0.1	0	0	0
Rajma bean	0.11	0.11	0	0	0
Soya bean	0.1	0.11	0	0	0
Soya bean	0.12	0.13	0	0	0
Black pepper	0.07	0.08	0	0	0

Cardamom	0.12	0.13	0	0.31	0
Ginger	0.13	0.13	0.01	0.02	0
Herbs and MAPs	0.07	0.08	0	0	0
Turmeric	0.13	0.13	0	0	0
Mustard	0.12	0.12	0	0	0
Pyrilla	0.1	0.09	0	0	0
Sunflower	0.12	0.11	0	0	0
Sugarcane	0.1	0.12	0	0	0
Tea	0.1	0.04	0	0	0.01
Areca nut	0.11	0.09	0.02	0.02	0
Coffee	0.09	0.08	0	0	0
Hazelnut	0.09	0.1	0	0	0
Sunflower	0	0	0	0	0
Button mushroom	0.04	0	0	0	0
Oyster	0.04	0.04	0	0	0
Shiitake	0.08	0.04	0	0	0
Beans	0.1	0.12	0	0	0
Bitter gourd	0.07	0.08	0	0	0
Brinjal	0.07	0.1	0	0	0
Broccoli	0.09	0.12	0	0	0
Cabbage	0.04	0.04	0.01	0	0
Carrot	0.06	0.06	0	0.01	0
Cauliflower	0.09	0.12	0	0	0
Chilli	0.12	0.14	0.01	0	0.01
Garlic	0.09	0.09	0	0	0
Green leaves	0.08	0.12	0	0	0
Onion	0.1	0.1	0	0	0.01
Potato	0.12	0.13	0.06	0.13	0.01
Radish	0.08	0.12	0.01	0	0
Tomato	0.1	0.1	0	0	0.01

Annexure 4: Preference Score and Rank for food and nutrition security crops

Commodity	**Crops**	**Preference Score**	**Rank**
Cereals	Rice	0.43	1
	Maize	0.07	2
	Wheat	0.05	3
	Buckwheat	0	4

	Millet	0	5
	Quinoa	0	6
Vegetables	Potato	0.2	1
	Chilli	0.02	2
	Onion	0.01	3
	Cabbage *	0.01	4
	Tomato	0.01	5
	Carrot *	0.01	6
	Radish *	0.01	7
	Beans	0	8
	Green leaves	0	9
	Brinjal	0	10
	Cauliflower	0	11
	Broccoli	0	12
	Garlic	0	13
	Button mushroom	0	14
	Oyster	0	15
	Shiitake	0	16
	Bitter gourd	0	17
Fruits and Nuts	Citrus	0.16	1
	Apple	0.02	2
	Banana	0.01	3
	Mango	0	4
	Pear	0	5
	Walnut	0	6
	Persimmon	0	7
	Avocado	0	8
	Kiwi	0	9
	Dragon fruit	0	10
	Passion fruit	0	11
Grain legumes and Pulses	Rajma bean	0	1
	Soya bean	0	2
	Soya bean	0	3
	Lentils	0	4
	Adzuki bean	0	5
	Chickpea	0	6
	Groundnut	0	7
	Mung bean	0	8

*Deleted from the priority list following several consultations with policy and decision makers

Annexure 5: Weightage allocation to criteria using Analytical hierarchy Process (AHP)

Decision Matrix

	Commercial Potential	Production Potential	Avg. Production	Avg. Export Volume	Avg. Import Volume
Commercial Potential	1	1	2	0.33	0.33
Production Potential	1	1	2	0.5	0.33
Avg. Production	0.50	0.50	1	0.33	0.25
Avg. Export Volume	3	2	3	1	1
Avg. Import Volume	3	3.00	4	1.00	1
Sum	8.50	7.50	12.00	3.17	2.92

Normalized Decision Matrix

	Commercial Potential	Production Potential	Avg. Production	Avg. Export Volume	Avg. Import Volume	Total	Average	Consistency Measure
Commercial Potential	0.12	0.13	0.17	0.11	0.11	0.64	0.13	5.05
Production Potential	0.12	0.13	0.17	0.16	0.11	0.69	0.14	5.03
Avg. Production	0.06	0.07	0.08	0.11	0.09	0.40	0.08	5.02
Avg. Export Volume	0.35	0.27	0.25	0.32	0.34	1.53	0.31	5.08
Avg. Import Volume	0.35	0.40	0.33	0.32	0.34	1.74	0.35	5.07
Sum	1.00	1.00	1.00	1.00	1.00		1.00	

Random index and consistency ratio

Consistency Index	CI	0.01
Random Index	RI	1.12
Consistency Ratio	CR	0.01

Weightage for criteria

Criteria	**Weightage**	**Weightage (%)**
Commercial Potential	0.13	0.13
Production Potential	0.14	0.14
Avg. Production	0.08	0.08
Avg. Export Volume	0.31	0.31
Avg. Import Volume	0.35	0.35

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