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GRAND CHALLENGE

for development of

"Technologies for Primary Processing, Storage and Valorization of Onions"

The Ministry of Consumer Affairs, Food and Public Distribution, Department of Consumer Affairs announces to develop '*Technologies for Primary Processing, Storage and Valorization of Onions'.*

Background

Department of Consumer Affairs, Ministry of Consumer Affairs has the objective of providing quality Agri-produce and products there off to the consumers at large at affordable price. One of the critical commodities is Onion whose price fluctuates significantly due to several reasons. Onions not only provide flavor, they also provide important nutrients and health-promoting phytochemicals. It contains vitamin B and a trace of vitamin C and also traces of iron and calcium. As a culinary ingredient it adds to the taste and flavour in a wide range of food preparations and it is also used as a salad. Thus, there is a steady increase in the demand for onion across the world. Onion production in India is around 26.91 million MT from an area of 16.28 million hectares (2020-2021). On average, India consumes an estimated 1.3 million tonnes of onion every month, and to meet this demand, the crop is grown in three seasons – Kharif (planted between July-August and harvested in October-December); late Kharif (planted between October-November and harvested in January-March); and Rabi (planted between December-January and harvested in March-May). So, the Rabi onion crop is the mainstay of India. Normally, the price of the onion is lower during these months due to greater supply. It is critical for India to successfully store rabi onions to maintain its market supply during lean months. Additionally, scientific management of onion production in all three seasons is also essential in augmenting regular supply. If the area coverage of the Rabi crop is smaller due to non-availability or limited availability of irrigation water or if the crop is damaged due to hailstorms and pre-monsoon rains, production will be lower, consequently, the prices rise.

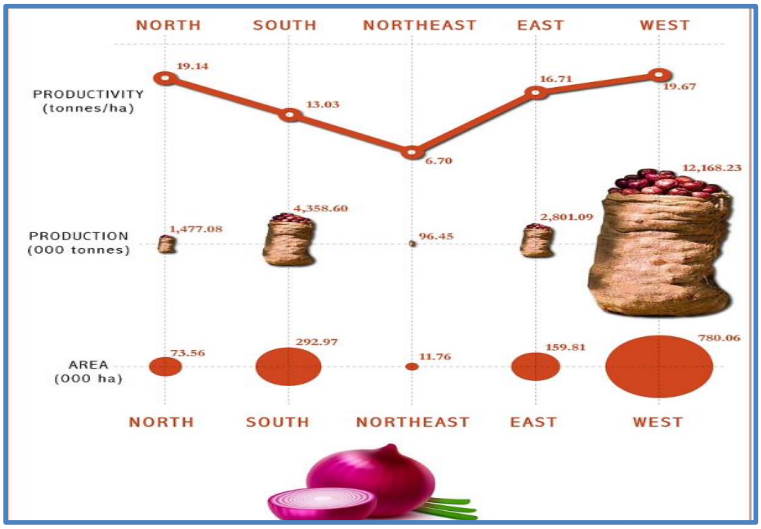

Fig.1 Region-wise area, production and productivity of onions in India

Due to improper storage systems, annual losses amount to about Rs 11000 Cr. It is prudent to invest a decent amount in the development of technological solutions to the problems plaguing the Onion sector and dividends will be attractive. Although the traditional method of making onion husks saves money, the loss of storage is huge and these huts are not economically viable.

Recent technological advancements (such as Design, Solar/Plasma/Irradiation energy, Nanotechnology, IoT including AI/ML) also offer an opportunity to provide infrastructure for onion storage and supply chain besides value addition even in rural India. Design innovations are pervading various sectors including efficient onion storage at farm level, rural as well as urban markets. Different process and product development advances will fetch better returns to farmers and competitive prices for consumers. More importantly, it will help in addressing the present as well as impending challenges.

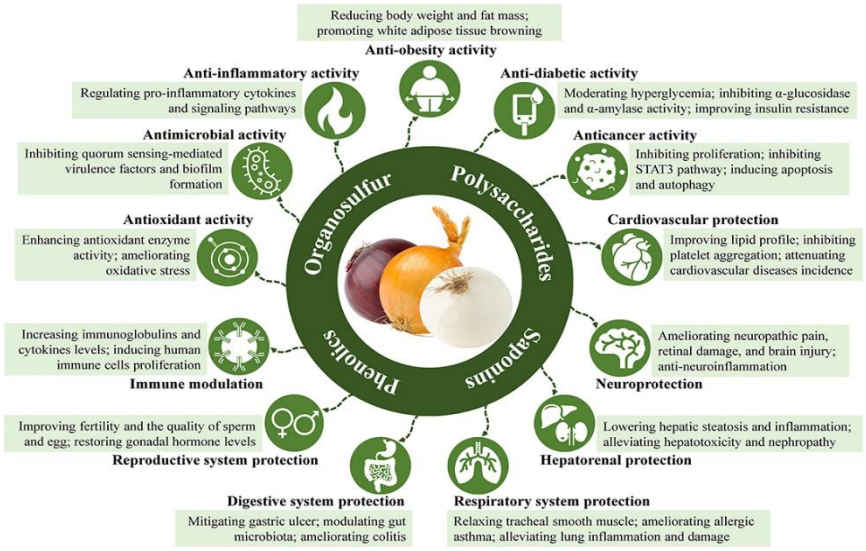

Fig. 2. Health benefits of onions

<u>Grand Challenge Problem Statement:</u>

The Onion storage grand challenge invites a proposal for developing ' Technologies for Primary Processing, Storage and Valorization of Onions'.

The proposed comprehensive solution for the mega issue should focus on the following:

Vertical 1: *Improvements in the designs of storage structures*

Vertical 2: *Pre-harvesting stage*

Vertical 3: *Primary Processing*

Vertical 4: *Vaporization: Value addition and utilisation of unconsumed and excess onions*

Vertical 1: ***Improvement in the design of storage structures***

Onion is a semi perishable vegetable and is harvested during *rabi* season accounts 65% of onion production, hits the markets from April to May. The same crop must continue to meet the consumer demand till the month of October-November every year before the *kharif* crop is harvested and brought to the market. *It is therefore vital to successfully store onion in order meet the regular supply.* It is observed that nearly 30-40% of the crop is lost during storage due to the various reasons in form of physiological weight loss, rotting, sprouting etc. In unexpected situations such as natural calamities, the losses even go beyond 50% creating heavy stress both on demand and supply sides. The losses occurred during storage are in terms of qualitative as well as in quantitative ways. Hence, it is imperative to take some crucial steps pertaining to onion storage with minimum losses to ensure the adequate supply to the market there by reducing the price fluctuations.

Table 1: Current Quantitative losses and Expected Targets

	Type of loss	**Reported losses**	**Expected loss with potential solutions**
1	Physiological weight loss (PLW)	20-25%	15-20%
2	Rotting/ decay	10-12%	≤ 7-10%
3	Sprouting	8-10%	≤ 6-7%

Qualitative losses:

1. Black mold : 25-30% reduction in market value
2. Outer skin removal : 25-30% reduction in market value

Various abiotic factors like temperature, relative humidity affects the health of onions hence their balance is must needed to store the crop with minimum losses.

- *High temperature (Above 32°C) + Low RH (Less than 60%) = Weight loss*
- *Low temperature (0 - 2°C) + Low RH (Above 70%) = Sprouting*
- *High Temperature (Above 32°C) + High RH (Above 70%) = Rotting*
- *Temperature (25-30°C) + RH (60-65%) = Recommended*

  OR

  **Temperature (0-5°C) + RH (65-70%) = Recommended*

Note 1 - When removing the onions from cold storage, they must be heated up/conditioned to the outside temperature to avoid post-storage sprouting and the decay temp should not increase more than 2°C/day. This process of conditioning requires great energy and a lot of time where the scope of improvement is needed.*

Note 2- The irradiation treatment of onion bulbs in which sprouting has not been initiated is recommended during the vernalization process at low temperature before storage, otherwise it makes black colour spot inside the bulb.

Scope of improvement

1. *Optimization of various abiotic factors during tempering / conditioning.*
2. *Development of sensor-based detection system of onion weight loss/ rotting/ sprouting/ decaying etc.*

Status of established onion storage structures and challenges

i. *Naturally ventilated structures (Kandha Chawl):*

Kandha Chawl are the naturally ventilated structure, a scientific onion hut to minimize the losses due to storage. In India, the onions are mostly stored in such structures without any control of temperature and relative humidity. The farmers construct different types of Kandha Chawl based on the capacity required.

*Low-cost thatched roof bamboo storage structure***:** This type of storage structure is usually constructed with bamboo framework having the roof made up with sugarcane leaves and is preferred for 'on-farm' storage of onions. This is a single row storage structure that can be made of 5 to 10 tones capacity. The structure is constructed with bamboo rafters. The whole solid bamboos are used for pillars and roof beams. Half split bamboos are used for floor while the sidewalls are made by split bamboos (1/6). The pillars of whole bamboos are erected at five feet distance. The iron angle provide support to all pillars. The bottom ventilation is provided with bricks fixed at the base of all iron angle pillars. The roof is usually made with sugarcane leaves but similar type of grass-can be used for this purpose. Inner lining of gunny cloth is provided to check the leakage of rainwater. This type of structure should be made in North to South direction. This type of storage structure is low cost and easy to construct, but leads up to 40-42% losses of onion during four months of storage. The durability of the structure is low due to use of organic material / bamboo. The temperature and humidity cannot be controlled since it works on natural ventilation mechanism.

Fig. 3. Low volume structure

Table 2: Challenges in the current designs and expected Targets

Challenges in current designs	*Scope of Improvement in current design*
1. Durability and strength of storage structure	Material used in construction (decided by participants as per challenges)
2. 40-42% losses	Loss reduction range must be: 20-25%
3. Low storage duration (as onions can be efficiently stored upto 3-4 months)	Extension of storage period with minimum loss
4. Abiotic factors	• Control of environmental parameters and ventilation. If needed cost friendly accessories like Fan, tubelight etc. can be used in the storage structure. • 65-70 % RH • Temperature : 25-32 °C

Bottom and side ventilated storage structure: This has provision ventilated floor made of wooden bantams, central ventilated pathway and extended roof. **The framework of the structure was constructed with galvanized iron channels.** The floor and sides walls were made with wooden bantam of 2.5 cm thickness and gap of 2.5 cm in kept between the bantams. **The roof is constructed with asbestos sheets.** The roof was extended to 1 meter to avoid splashes of rain. This type of structure has a provision of ventilation from bottom and sides.

Fig. 4. High volume structure

These current prevailing structures that may vary in their capacity as well as the cost to fulfil the requirements of all income groups of farmers/traders. Though these naturally ventilated storage structures are well adopted, still considerable losses occur as there is no control of temperature, relative humidity and airflow which are very important

for successful storage of onion with minimum losses. The construction of the 50 MT double row modified bottom and side *ventilated storage structure needs approximately Rs. 7 lakhs.*

Majority of the farmers in India store the onion in this type of naturally ventilated storage structures but such structures are not suitable in regions with extreme high temperatures, and high relative humidity / high temperatures with low relative humidity or low temperatures with high relative humidity. ***There is a scope to improve this structure by providing proper ventilation, controlling temperature in extreme summer conditions, reducing relative humidity with suitable materials and other means****.*

Table 3: Challenges in the Current designs and Expected Targets:

Challenges	*Scope of Improvement in current design*
1. Reduction in cost	Cost should reduce (below 4-5 Lakhs)
2. Durability and strength of storage structure	Material used in construction (decided by participants as per challenges)
3. Reduction in storage losses (Current losses: ~ 46% in 4 months)	Losses up to 20-25 % in four months' storage
4. Abiotic factors	Control of environmental parameters and ventilation (natural convective air circulation) • 65-70 % RH • Temperature : 25-32 °C
5. Material used in construction (Currently, roof is of asbestos sheets)	The roof of material should be environmental friendly and prevent heat built-up at the top of the structure.
6. Environmental sustainability issue	Alternate to wood battens can be used in structure

ii. *Controlled onion storage structures*

Although cold storage systems are used in certain countries for onion, which is rarely adopted in India due to poor economics and lack of cold chain facilities required to maintain the quality in the high ambient temperature prevalent in our country. Onion storage in ventilation condition is quite satisfactory when the temperature is maintained between 25^{o}C to 30^{o}C with a relative humidity range of 65-70%.

In controlled onion storage structures, the onions are stored at 0-5°C and 60-65% RH that leads to much lesser losses as compared to ventilated storage structure. The cost of construction (approx. 20-25 lakhs/ 20 tons) and running cost

(i.e. Rs 0.60-0.65/ Kg/ month) are very high as energy required to maintain the storage facility in the temperature range of 0-5°C is high. The other problems are condensation and require lot of energy and time. The bulbs start sprouting immediately after they are removed from the cold storage.

Fig. 5. Controlled storage structure

Table 4: **Economics of cold storage**

S.No.	**Particular**	**Cost of onion storage/ton**	**Cost of onion storage/ 2000 ton**
1	Total storage capacity (tones)	1	2000
2	Value of onion @ Rs 2000/ton	2000	4000000
3	Cost of storage of onion (Rs/year)/ Repayment	900	1800000
4	Cost of sorting @Rs 70/ton	70	140000
5	Cost of electricity charges	200	400000
6	Maintenance and interest on capital	500	1000000
7	Cost of irradiation	15	30000
A. Total expenditure (Rs)		3685	7370000
	Total salable good bulbs (ton)	0.95	1900
	Total salable Sprouted and black mould bulbs (ton)	0	0
B. Total Returns (Rs)	Onion @ Rs 6000/t	5700	11400000
	Sprouted & black mould affected bulbs @ Rs1000/ton	0	0
	Total value (Rs)	5700	11400000
8	Net profit (Rs) (B-A)	2015	4030000
9	Net Profit (Rs/t)	1.0075	2015

Table 5: Challenges in the Current designs and Expected Targets:

Challenges	*Scope of improvement*
1. Proper circulation of cold air inside the structure	Forced circulation of cold air Temperature optimization

	• Ambient temp. storage: 25-32°C • Cold storage: 0-5°C • 65-70 % RH
2. High capital investment and operating cost	Should be cost effective (below 10-12 Lakhs/20 tons)
3. High energy requirement and power failure affect the storage life of onions.	Method adopted must enable constant and cost effective power supply (e.g. Solar energy etc.)
4. Environmental sustainability issue.	Must provide an alternative to refrigeration system (like cooling towers etc.)
5. Required highly skilled manpower	Less skilled manpower requirement (by making the system user friendly)
6. Durability and strength of storage structure	Material used in construction (local agri material, decided by participants as per challenges)

Table 6: Economic Evaluation of Kanda Chawl

Particulars	**Low-cost thatched roof storage structure**	**Modified bottom ventilated double row storage structure**	**Modified Bottom ventilated storage structure chain linked side walls**
Other/ Common names	**Low-cost thatched roof bamboo storage structure**	Bottom and side ventilated (Two row subsidised structure)	Bottom and side ventilated structure fabricated with chain link/ wire mesh
Cost of construction (Lakh Rs)	0.05	1.9	1.25
Length (m)	4.9	9.9	9.9
Width (m)	1.2	6.0	3.6
Side height (m)	1.6	2.25	2.25
Central height (m)	1.9	4.5	4.0
Storage capacity (tones)	5	42	25
Expected life (years)	5	20	20
Cost of storage (Rs. /Kg/month)	~0.20	~0.23	~0.25

Economics of storage of onion			
Total expenditure (Rs)	12850	109040	82090
Total expenditure (Rs/ton)	2570	2596	2565
Total Return #(Rs)	18884	123210	98068
Net Profit (Rs)	6034	14170	15978
Net Profit (Rs/ton)	1207	337	499

#Cost of onion: A grade- @ Rs 5500/t, Sprouted & black mould affected-@ Rs1500/t.

Several losses have been reported pertaining to PLW, Rotting, scale removal, sprouting and black mould when onions are stored in storage structures like Low cost thatched roof structure, Modified bottom ventilated double row storage structure or structure with structure chain linked side walls etc.

Table 7: Different types of losses (average) are reported in Rabi Onion that are stored in different storage structures and expected outcomes from potential solutions.

	Current status (averages losses)					**Expected Outcomes**				
	PLW (%)	**Rot (%)**	**Scale removal (%)**	**Sprouting (%)**	**Black mould (%)**	**PLW (%)**	**Rot (%)**	**Scale removal (%)**	**Sprouting (%)**	**Black mould (%)**
Low cost Thatched roof structure	17.4	10.8	0.34	1.35	2.11	Minimum 40-55 % reduction in all category losses in comparison to the existing loss				
Modified bottom ventilated double row storage structure	19.4	17.94	0.32	37.69	11.6					
Modified Bottom ventilated storage structure chain linked side walls	22.7	14.19	0.38	3.29	5.58					

Vertical 2: Pre-harvesting stage: Pre-harvest care such as field heat removal, curing, preliminary storage, adopting traditional methods

By following the below mentioned pre- and post-harvest management practices storage losses can be curtailed.

Pre-harvest care/ practices	Post-harvest care/ practices
• Selection of suitable material that prolongs the storage time and capacity.	• Proper field curing after harvest for 2-3 days by covering the bulb with leaves. De-topping the bulb by leaving 1-2 inch at the top of the bulb
• Proper irrigation from time to time without any dry spell	• Shade curing for 10-14 days
• Application of recommended dose of fertilizers at proper time. Excess application of nitrogen is reported to increases the rotting losses during storage.	• Sorting and grading before storage and storage according to grades
• Neck fall is an indicator of maturity stage hence, best time to harvest is at 50% of neck fall maturity.	• Disinfection of storage structure before loading of onions

Curing

Curing is a drying process carried out to remove excess moisture from the outer skins, roots and neck tissues of harvested onion bulbs. It improves the keeping quality of onion bulbs and reduces the chance of infection by disease causing organisms during storage. The term “curing” is preferred because the removal of moisture is only from the outer scale, rather than from throughout the bulb. An onion bulb is a series of concentric swollen leaves attached to a short stem. Curing surface scales provides a dry barrier around the onion bulb and a sealing against water loss. Curing increases hardness of the bulb and helps to develop colour of cured bulb. Onion curing can be done in the field with natural convection of air or with forced circulation of hot air using artificial curing chambers. In traditional small-scale operations, onion drying is carried out in the field by a process called *windrowing*. It involves harvesting the mature bulbs and laying them on their sides (in windrows) on the surface of the soil to dry. During curing process, cover the bulbs with onion leaves to prevent sun burn. Field curing for 2-3 days in windrow method by covering with leaves, removal of foliage leaving 2-3 cm neck and then shade curing for 10 to 15 days to remove the field heat and excess moisture from the surface of bulbs is recommended for improving the storage quality of bulbs. Extra short necks increase the likelihood of disease infestation.

Field curing has limitations due to unexpected rains during harvesting time, lack of proper security and other socioeconomic reasons. If dry conditions prevail during the harvesting season, the bulbs can be cured well in the field and in the on-farm store. During wet weather, the bulbs can take longer time to dry and may develop higher levels of rots during storage. Artificial curing could be beneficial during wet weather. Through artificial curing, we can have the

control on the temperature and time of curing. Onion curing by artificial means may help to reduce post-harvest losses during wet harvesting seasons, but the economics and feasibility of such operations may preclude their application.

Table 8: Challenges faced during Pre-harvesting stage

Challenges
• Systematic study of field curing on storage losses, bulb quality, biochemical quality and disease incidence of rabi season is required.
• Design of Artificial curing system
• Translocation photosynthates and nutrients from foliage to bulbs need to be studied during curing
• Mechanization of onion harvesting
• Mechanization of onion detopping/ combined de-topping and grading system.

Table 9: Scope of improvement and targets for the Primary Storage of Onions

Parameter	**Present status**	**Expected output/improvement**
Storage losses	20-30 % w/w	15-20%
Biochemical quality	Biochemical analysis (Pyruvic acid, quercetin, thoisulphonate values etc.) after curing/ before storage	Non-significant/ minimal variation in studied biochemical parameters values during storage
Suitable material and scope for innovation/ improvement	To be decided by participants as per challenges	

Table 10: Pre-harvest/Preliminary Storage Parameters.

No	Parameters	Freshly Harvested Value	Permissible value After 6 Month Storage
1	Density (Onion Bulbs)	900 kg/m^3	800-850 kg/m^3
2	Moisture Content	90 % (w/w)	85 % (w/w Min)
3	RH	~ 50 %	40 - 45 %
4	Light/Illumination	25,000 – 30,000 Lux	2000 - 2500 Lux (Dark room)
5	Air Velocity	Natural, Seasonal Value	0.1 - 0.2 m/s (Air velocity across storage)
6	Pressure	-	0.1 - 0.2 kg/cm^2
7	Direction of Bulb storage	Un symmetric	Symmetric (Shoot facing top and germinating end to bottom)
8	Storage Period	2 - 3 months	6 - 8 Months
9	Cost of Storage	Rs 0.5 - 1 /kg/Month	Rs 0.25 - 0.5 /kg/Month
Storage inside the soil (Replication of soil conditions)			
1	Direction of Bulb storage	Un symmetric	Symmetric (Shoot facing top and germinating end to bottom)
2	Pressure	-	0.1 - 0.2 kg/cm^2
3	Light/Illumination	25,000 – 30,000 Lux	2000 - 2500 Lux (Dark room)

Vertical 3: Primary Processing

Primary processing also includes curing, grading and sorting, storage and other treatment to reduce sprouting like irradiation.

Grading: Onions are graded before they are stored or transported to the market. The thick necked, bolted, doubles, injured, and decayed bulbs are picked out.

Onion size grading of following diameters:

a. Large: > 60 mm
b. Medium: 40-60 mm
c. Small: 20-40 mm

Irradiation of onion: Object of irradiation is to control losses due to sprouting of onions during prolonged storage. Sprouting issue can be controlled by using irradiation technique with low dose: 0.06-0.2 k Gray. Benefits include economic gain due to reduced sprouting losses which could be as 10 - 15%.

Table 11: Challenges encountered during primary processing

Challenges
• Improvements in existing grading systems
• Reduction in processing time
• Cost effective alternative process to irradiation process to control sprouting (like linear accelerators, cold plasma etc.)
• Curing related challenges are mentioned above in vertical 2

Vertical 4: Valorization: Value addition and utilisation of utilisation of unconsumed/excess onions

Valorization of onion waste would be alleviating the negative consequences derived from the accumulation of high antioxidant biomolecules, and also provide an economic benefit for both the onion producers and processors. Processing of onion into various ready-to-eat or ready-to-use forms would increase the consumption. Processing of onion into various products like, dehydrated flakes, powder, onion oil, minimally processed onions, onion paste etc. will allow the effective utilization of onions waste.

Onion can be processed into different value added products i.e.

(1) **Minimally processed onions**: These are peeled and/or cut onions for ready to use that retain its freshness, packed in suitable packaging material and stored at refrigerated conditions or frozen conditions.

(2) **Onion paste**: Onion is grounded yet retaining its freshness. Preparation of minimally processed onions and onion paste entails optimization of proper preservatives and packaging materials to increase the shelf life of these products.

(3) **Dehydrated onions:** Dehydration of onions reduces the bulk to transport and also increases the shelf life of onions significantly due to less moisture, which arrests the growth of microorganism. *Use of suitable packaging techniques is the most important to increase the shelf life of dehydrated onion flakes* and powder as these are very hygroscopic in nature.

(4) **Pickles**: Most widely used pickling for onions are vinegar based pickling and oil based pickling.

(5) **Oil**: Onion oil is also used as a natural food preservative in some food products.

(6) **Vinegar/Beverage/Sauce**: As the onions are rich in sugars and other nutrients they can be processed into onion vinegar and onion wine.

Processing of onion into different value added products would reduce the post-harvest losses, and reduce the bulk to transport and cost of transportation. Among the different value added products, dehydrated products have the major demand as they offer convenience, more shelf life, reduction in bulk etc. Dehydrated onions are an important product in world trade and India is the second largest producer of dehydrated onions in the world. India is a major supplier that fulfil the onion demand constituting 89% of global production. The demand for Individually Quick Frozen (IQF) onion is also increasing.

Characteristics of onion varieties for dehydration

1. **Appearance**

   White colour onion is preferred for dehydration due to their appearance and preference in the market.

2. **High Total Soluble Solid (TSS) content**

   Onions with high TSS (18-26%) are most vital attribute for the processing (dehydration). High TSS bulbs will have less moisture for dehydration, requires less energy and needs less dehydration time, which in turn gives white (rather than yellowish) products, give higher product yield, at lower cost of processing.

3. **High pungency (pyruvic acid ≥ 4 µmolg^{-1})**

   High pungent varieties are preferred for dehydration for better flavor retention after dehydration.

4. **Low ratio of reducing to non-reducing sugar**

   It reduces the discolouration and browning during drying.

5. **Resistance to diseases, moulds and insects**

   Good quality onion with low diseases, moulds and insects both in the field and during storage increases the acceptability of an onion cultivar for processing

   Scope of improvement: The energy requirement is more in processing of onion hence, solar energy-based techniques may be encouraged.

Table 12: Value added products available in market with their processing time, process and their market value.

S.No	Product	Market price	Total Market value (worldwide, USD)	Processing time	Process	Scope of improvements

1	Dehydrated onion powder	90-130	208.37 Million	**6-8 hours** (if high humidity, around 80%) or **4-6 hours** (if low humidity)	Dehydration	*Optimization of current designs to reduce the processing time and make the product economical*.
2	Onion rings(Fried)	250	N/A	Fried product (**5 min**.)	Cutting, breading, frying	
3	Onion puree/paste	80 -100	N/A	**8- 10 min**	Milling	
4	Onion salt	540	N/A	Spray drying of onion juice + mixing with salt	Spray drying	
5	Minced onion	70 -90	N/A	**8-10 min**	Dehydration	
6	Onion Juice	70	N/A	**8 -10 min**	Extraction	
7	Pickled onions	110-125	N/A	Pickled onions are a food item consisting of onions pickled in a solution of vinegar and salt, often with other preservatives and flavourings.	Pickling	
8	Onion flakes	115- 128	N/A	**Mincing** of onion and dehydration	Cutting, dehydration	
9	Onion Oleoresin	1200 – 1500	N/A	Onion powder is filled in columns and extracted with various solvents such as Hexene, acetone etc. The total process - **8 hours**.	Solvent extraction	
10	Onion oil	2000 – 2500	40.2 Million	Distillation to extract volatile components. Process time - **4-6 hours**	Distillation	

Table 13: Valorisation potential By-product and utilization of unconsumed/excess onions and challenges

Sl. No.	**Valorisation potential**	**Challenges**
1.	Onion drying and dehydration	1. Varietal improvement for high TSS (both white and Red onions) 2. Design and development of energy efficient and low cost drying methods/ machines (solar, hot air mechanized and /or combination of both).

		3. Prevention of enzymatic and non- enzymatic browning during drying and storage
2.	Onion paste	1. Prevention of enzymatic and non- enzymatic browning after paste making and during storage 2. Minimizing whipping of paste 3. Improving shelf-life of onion paste
3.	Extraction of potential nutraceuticals/ bio-active compounds of onion	1. Identification and screening of nutraceutical rich onion varieties 2. Identification and /or development of methods for extraction of nutraceuticals 3. Concentration of nutraceuticals/ bio-active compounds 4. Development of nutraceutical rich food products/ functional food with medicinal properties.
4	By-product and waste utilization	1. Use of onion leaves in value added products 2. Use of onion wastes (leaves, peels, spoiled onions, seed husk) in biogas generation 3. Development of edible packaging material from onion waste.

Eligibility Criteria:

1) The following participants (college students, research scholars, faculties, and industry individuals) can apply. Team Leader of the participating team must be Indian citizen.
2) Participants will be categorized under two tracks which are as follows;
    - Track 1- Students (UG/PG/Diploma), Research Scholars, Faculty
    - Track 2- Industry individuals, Tech start-ups, MSMEs, LLPs, Professionals
3) The above-mentioned participating teams are not mandatorily required to be registered with Indian Companies/startups / MSMEs LLPs to apply for the challenge. However, the teams shortlisted at second stage (PoC to product stage) will be required to apply for registration as Indian Startups/ Company/ MSMEs/ LLPs and submit the proof of having applied at the final stage (field implementation). It will be expected that by the time of selection at the final stage, necessary registration will be completed. Exceptions will be considered at any stage of challenge.
4) The Indian Tech start-ups, MSMEs, Companies, LLPs registered in India under the company Act can apply. The entity must have 51% or more shareholding with Indian citizens or persons of Indian origin.

Note:

- Funds will be transferred only in the bank accounts of Startups/companies / MSMEs / LLPs and not in the bank accounts of individuals.
- Product/technology IP (Intellectual Property) will belong to the innovator.

Implementing Agency

MoCA would be the primary agency for conducting the grand challenge and Ministry of Education's Innovation Cell (**MIC**) and **AICTE** would be acting as Knowledge partners.

DoCA would be the user agent of the Grand Challenge and would provide locations and financial support for

sourcing and installation of Storage structural solutions/product production centers/demo plants, deployment of technologies as well as logistics, travel, and other contingency expenses.

Evaluation Methodology

Blind Review: An expert panel from Academia, Government, and Industry will evaluate the proposals and will shortlist approximate 40 proposals.

Stage–1 (Ideation to PoC): Shortlisted teams will be asked to make a presentation to Jury*. Based on the recommendations of Jury, 40 proposals on verticals will be shortlisted. The financial support of Rs. 1 Lakh each to develop a proof of concept (PoC) and/or a working prototype of the proposed solution within **3-4 months** duration would be provided. In this stage, a workable process is to be explained to show the PoC or to design and develop a prototype to demonstrate to the Jury members consisting of experts from Academia, user agency (DoCA), MoCA, Industry, etc. The winning team of stage 1 will receive prize money of Rs.25000.

Stage – 2 (PoC to Product Stage): This is the critical phase of the grand challenge to build upon the idea and mature the prototype. The teams would present their prototypes to Jury. Best Twenty (20) techno-economically viable prototypes and processes shall be selected for product/Process development and each team will receive development amount (Rs 5 Lakh) to build their solution as per the need of the user agency within *six-twelve months* duration (max) and subsequently field trial, testing & deployment, and demonstration at approx. 25 locations across the country as identified by user agency in next *6-8 months.* These teams shall be provided with additional financial support, if necessary, for handholding by the Department of Consumer Affairs, MoCA, MIC & AICTE (knowledge partner) and the implementing agency (DoCA) for testing, deployment, and demonstration at the live site. The winning team of stage 2 will receive prize money of Rs. 50,000.

- For these field trials, each finalist will be provided the following financial support
- For sourcing and installation of devices/solutions deployment
- For logistics, travel, and other contingency expenses. The cost of sourcing and deployment of devices and solutions will be estimated by the implementing agency based on the business plan submitted by the applicants, inwhich such costs have to be mentioned explicitly.

Stage – 3 (Filed implementation stage): The selected teams of Stage-2 will get a chance of a lifetime to deploy a fully functioning product/process at a location earmarkedby the user agency. The products/processes will be presented to Jury and user agency. The solutions would be evaluated based on parameters that will include Innovation, Replicability, Scalability, Usability, Price of the product, Ease of deployment/roll-out, Potential risks involved in the implementation of the solution etc. Based on the evaluation, one winner in each category and two/four runner-ups will be selected and supported appropriately for the field deployment of the solution.

All teams including the winning team shall be free to market the product to any entity outside the user agency with consent of user agency, if required. Intellectual property (IP) of the developed novel product/ process would belong to the innovator.

Evaluation Parameters and quantifiable matrix to be adopted by the implanting agency

The ideas/ process/prototype/ final product/process will be judged on the following parameters

	Parameter	Description
1	**Novelty**	Product idea, degree of innovation, simplicity of final solution, uniqueness & scalability of idea, novelty of approach,
2	**Business Use Case**	Business Case, USP, and vision
3	**Technical Feasibility**	Product features,Interoperability, enhancement & expansion, Underlying technologycomponents & stack and futuristic orientation
	Scalability	Evidence of operating at large- scale and effectiveness
4	**Product/Process Roadmap**	Potential cost to build product, go tomarket strategy, time to market
5	**Team's competency**	Team leader's effectiveness (i.e. Ability toguide, ability to present idea), ability tomarket product, growth potential of organization
6	**Cost effectiveness**	Cost of components/equipment/energy source

The weightage of each parameter is elaborated in ICTGC scheme document. Theimplementing agency has to adopt the same weightage criteria.

Incubation and Marketing support by MoCA F&PD

a) The successful developers may be given an opportunity to join the MoCA/Govt. supported incubator / CoEs for further nurturing of their solution. This will be facilitated by a challenge implementing agency.

b) The technologies that were developed & demonstrated successfully and approved by the Competent Authority may be listed in GeM.

c) MoCA, F&PD may facilitate in the deployment of successfully developed solutions in other emerging geographies.

Duration of ICTGC:

Total duration of the challenge would be **12** months (ideation, prototype and productstage) with maximum extension of 3 months depending upon the requirement of project.

Registration :

All Track I and Track II participants can register their entries on https://doca.gov.in/goc/.

The last date for registration and submission of idea for all the four verticals is **15.10.2022.**