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Precious supply chain management of onion (*Allium cepa L*) by examining the production, quality expansion & market analysis for food safety

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Abstract
Onion is an important and essential vegetable in kitchen as condiment and vegetable which captures an extensive internal as well as external market. The green leaves, matured and immature bulbs are eaten raw or used in preparation of vegetables. It is used as salad and cooked in various ways, in all curries fries boiled or scorched onion. It is also used in processed form e.g. flakes, powder, paste, pickles and some seasoning foods. It is valued much on account of its characteristics pungency which is due to presence of sulphur compound *(Ally propyl disulphide).* It contents some important medicinal properties. The organic onion is flourishing mainly due to consumer choice. The organic onion is much preferred than traditionally grown. It makes an increase in varieties and selection of onion in retail, supermarket and restaurant. The market plays an important role in determining the pattern as well as the pace of diversification in favor of high-value crops like onion. An increase in production is of little value unless there is a good marketing system.
Keeping the above view a research analysis on "Precious supply chain management of onion (*Allium cepa l*) by examining the production, quality expansion & market analysis for food safety" was carried out and found among two zones selected such as eastern coastal plateau zone & mid central table land zone, Mid central table land zone found most suitable for onion farming and fulfilling all most all farming requirements. Effect of organic nutrient and botanical pesticides on onion applied, the best onion varieties response to vermi compost (50%) that is 2 t/ha + NPK (50:50:50) 50 Kg each / ha was remarkable and best organic treatment. Effect of cultivation of different onion varieties found best results with onion variety Agri found Dark Red which has got best results in concern to growth & yield. Effect of integrated weed management on weed density, Dry matter weight of weeds & weed control efficiency found best results with weed control treatment one hand weeding at 20 Days After Transplanting + Ridge & furrow making (6" X 6") length X breadth in onion variety N-53.
Market survey found best results with variation within experimental period of time analysis found Bhubaneswar has lowest variations of onion price from wholesale to retail sell price. And also experimental State have best control over onion price hike during the market research & experiment year that is survey results from year 2013 – 2017.
Supply chain management models analyses it is concluded that onion SCM developed after survey that is a new model from research to different marketing channel partner involvement and then grass root label point coverage's prepared and samples are tested in field found best results.
E- Onion marketing & digitalization found a fresh & best technology to reduce marketing costs and examined during experiment founds best response among primary, secondary & tertiary stock holders.
Among different onion farming treatments integrated organic onion production technology found best economic results in comparison to conventional onion farming technology that is C: B = 1.97 (Cost Benefit ratio) & net returns are best with organic onion production technology that is Rs. 1,95,802/- (Rs/ha).

Keywords: SCM onion; onion varietal performance; organic onion; onion market; digital market

Introduction
Onion is the nearly everyone important and indispensable vegetable in kitchen as condiment and vegetable which captured an extensive internal market. The green leaves, matured and immature bulbs are eaten raw or used in preparation of vegetables. It is used as salad and cooked in various ways, in all curries fries boiled or baked. It is also used in processed form e.g. flakes, powder, paste, pickles and some seasoning foods. It is valued much on account of it's characteristics pungency which is due to presence of sulphur compound *(Ally propyl disulphide).* It possesses some important medicinal properties such as carbohydrate 10.11gm, protein 0.92gm, fat 0.08 gm, fibre 1.4 gm, sugar 4.28 gm, calcium 22 mg, potassium 144 mg, vitamin C 6.4 mg, vitamin A 2 AU, vitamin A 2 AU, B 6 0.15 mg, niacin 0.08 mg, Vitamin E 0.02 mg, vitamin K 0.4 mcg apart from this other elements such as sodium, manganese, zinc, copper & selenium are also found in minute quantity.
The market plays an important role in determining the pattern as well as the pace of diversification in favor of high-value crops like onion due to regular demand of consumer for quality onion vegetables. An increase in production is of little value unless there is a good marketing system. India has been a traditional exporter of fresh onion. Both the export quantity and the value have fluctuated and, in some instances, where production has been particularly low, export bans have been imposed to Proc. IVth IS on Improving the Performance of Supply Chains in the Transitional Economies Ed.: P.J. Batt Acta Hort. 1006, ISHS 2013 240 safeguard the interests of domestic consumers. While large capital requirements and the high cost of production may sometime deter farmers, the high prices and efficient markets can attract farmers to produce such crops (Sidhu *et al*., 2010).

In this experiment base research with the following objectives the work has been carried out by the researcher to find out the most suitable system of quality improvement of onion bulb & sustainable onion farming technology, to examine the most suitable precision farming system by analyse global requirement and accessibility of precision model for precious onion production, to find out a suitable sustainable Supply chain management system for onion, to evaluate the effect of organic inputs in various onion varieties and technology suitability after field experiment and find out optimum give in and potentiality to full fill market requirement in terms of quantity and quality. to evaluate some onion cultivars and find out optimum give in and potentiality to full fill market requirement in terms of quantity and quality, to find out best weed control treatments by field experiment and assimilation of mechanical & chemical control factor, to suggest grower line department officials & students about the measures for increasing the export potential of onion from India and effective supply chain management channel.

& to determine & recommend a suitable onion farming package of practices by analysing the economics of onion production to marketing.

In view of the above constrain and opportunities, the present research and analysis entitled "Precious Supply Chain Management of Onion (*Allium cepa L*) by examining the production, quality expansion & Market analysis for food safety" carry out to find out the suitable channel of production, quality improvement, supply chain management along with export and import of onion in context with market analysis in global as well as national standard, which ultimately meet the global, national and regional onion requirements.

Methodology

This analysis and research on "Precious Supply Chain Management of Onion (*Allium cepa L*) by examining the production, quality expansion & Market analysis for food safety" was carried out during 2016 to 2018, for field experiment two Districts of Experimental State such as Dhenkanal, Kendrapara of Odisha, India selected and for analysis of post-harvest, marketing, export and supply chain managements parameters global area methodology use. The crucial point to analyse was to estimate the growth rate in area, production and productivity of onion in India, to examine the onion production among major countries in the world, to find out most suitable system of quality improvement farming system for sustainable onion farming, to examine the most suitable precision farming system by analyse global requirement and accessibility of precision model for precious onion production, to find out a suitable sustainable Supply chain management system for onion, to evaluate some onion cultivars and find out optimum give in and potentiality to full fill market requirement in terms of quantity and quality through field experiment of onion varieties, organic onion farming treatments & weed control parameters, to ascertain the share of major onion exporting and importing countries in world trade, to study the country wise production, export of onion and import of onion in India over the period, to suggest the measures for increasing the export of onion from India and effective supply chain management channel & to determine and recommend suitable onion farming technology by analysing the economics of onion production to marketing.

Random sample Soil Data of experimental site: The soil data randomly collected from the experimental District blocks where farmer cultivate *Allium* and experiment on onion vegetative as well as give in parameters are collected and analyse. Experiment sites were regularly supervised and data record as well as field work done exclusively.

Table 1

Name of Dist.	Block	pH	EC	OC	N	P	K	Zn	B	S	Fe
Kendrapara	Garadapur	5.7	0.985	0.35	175	11.5	192.5	0.12	0.09	3.5	21.4
	Derabish	5.9	0.918	0.38	190	11.2	181.8	0.15	0.10	4.3	44.8
	Marshaghai	5.9	0.382	0.43	215	11.7	204.3	0.41	0.61	4.4	41.3
	Pattamundai	5.8	0.421	0.44	220	11.5	202.3	0.40	0.59	4.3	41.2
	Aul	5.8	0.381	0.31	155	11.2	188.1	0.52	0.41	5.2	40.2
	Raj Nagar	5.8	0.341	0.41	205	11.8	118.3	0.52	0.49	5.1	41.8
	Mahakalapada	6.1	0.214	0.45	225	17.8	178.2	0.70	0.45	14.2	48.9
Dhenkanal	Dhenkanal Sadar	6.2	0.850	0.40	180	14.5	180.5	0.50	0.50	4.2	45.6
	Odapada	6.4	0.540	0.40	185	12.8	200.4	0.70	0.45	4.5	40.4
	Gandia	6.0	0.215	0.35	175	14.6	210.4	0.75	0.40	5.2	45.7
	Hindol	6.2	0.425	0.42	195	11.8	185.5	0.60	0.55	5.2	40.3
	Kamakhyanagar	5.9	0.825	0.45	210	14.3	190.5	0.50	0.42	4.0	46.4
	Kankadahad	5.8	0.375	0.36	180	11.2	1802	0.70	0.30	4.3	38.2
	Bhuban	6.1	0.725	0.37	225	11.6	185.6	0.65	0.50	4.7	42.5
	Parjang	6.2	0.445	0.30	165	11.4	205.5	0.55	0.37	3.8	38.8
Total 2 Dist	15 Block sample										

Climate of Experiment Site during the experiment

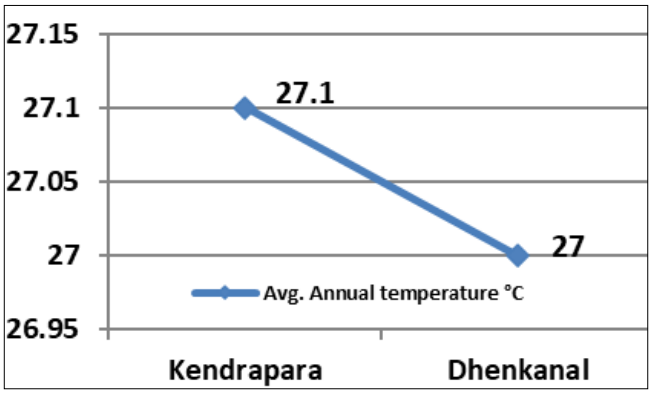

Fig 1: Avgerage Annual temperature °C field experiment District

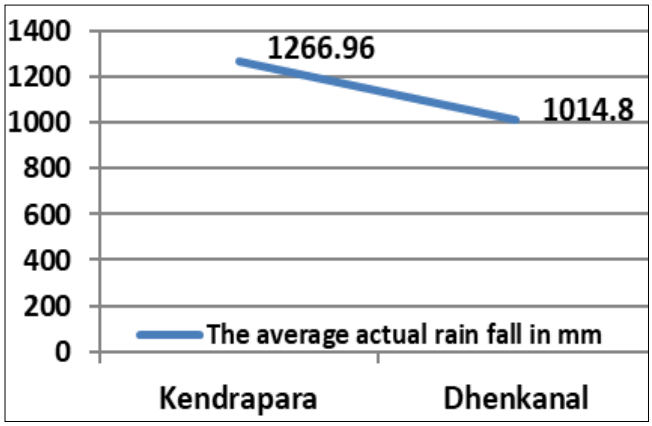

Fig 2: The average actual rain fall in mm in field experiment District

Latitude Longitude of Experimental State

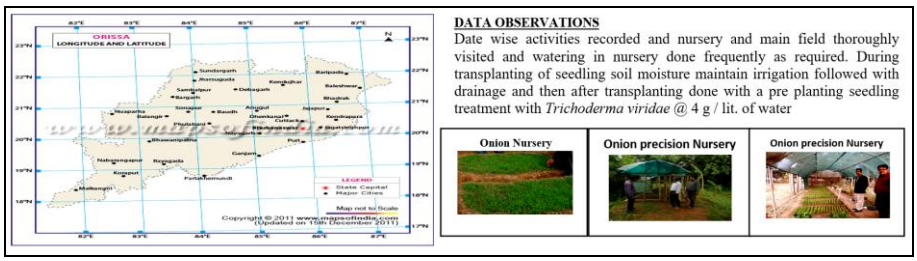

Fig 3

Experimental site Year wise rain fall

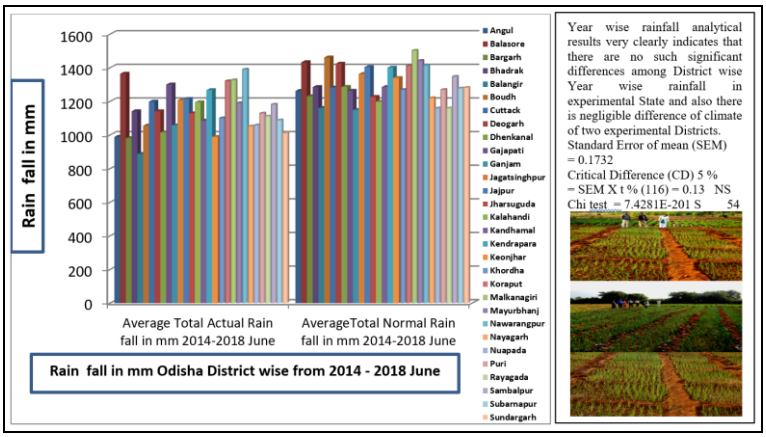

Fig 4

Table 2: Effect of organic nutrient and botanical pesticides applied at Post-harvest stages on Bulb weight (gm).

Treatment	Bulb Weight (gm)					Total	Average
	R1 V	R2V	R3V	R4V	R5V		
Control (T0)	40	45	45.8	37.2	36.8	204.8	40.96
Neem oil decoction 5 ml/litre at 15, 30, 45 DAT (T1)	42	47	48.5	37.5	37	212	42.4
Panchgavya 0.03 ml/liter water 0, 45 and 60 days after transplanting + NPK (50:50:50) 50 Kg. Each/ ha. (T2)	44	48	52	40	41.2	225.2	45.04
Trichoderma viridae 5 Kg/ha with FYM as basal dose + NPK (50:50:50) 50 Kg. Each/ ha. (T3)	40.5	45	46	35.2	35.5	202.2	40.44
Bio- fertilizer (Azotobactor + PSB) 2ml + 2ml foliar & soil drenching application 15 DAT, 30 DAT + NPK (50:50:50) 50 Kg. Each/ ha. (T4)	41.5	46.2	48	36.5	36	208.2	41.64
Vermi compost (50%) 2 t/ha + NPK (50:50:50) 50 Kg. Each/ ha. (T5)	46.5	52	55	42	43	238.5	47.7
Total	254.5	283.2	295.3	228.4	229.5	1290.9	258.18
Average	63.625	70.8	73.825	57.1	57.375		
Standard Error of mean (SEM) = 163.5869494 Critical Difference (CD) 5 % = SEM X t % (20) =341.24 Significant							

Resulted maximum weight of onion bulb in variety Pusa red variety of onion by application of Vermi compost along with macro fertilizers that is 55 (gm)

Table 3: Effect of cultivation of different varieties of Onion on Yield parameter after harvest

Treatment	Varieties	Bulb yield (q/ha)	Bulb weight (g)	Bulb length (cm)	Bulb girth(cm)
T1	Agrifound Rose	155.03	20.04	2.45	11.2
T2	Agrifound White	172.55	30.48	3.17	13.61
T3	Agrifound Light Red	211.24	42.88	3.78	14.83
T4	Agrifound Dark Red	284.44	50.66	3.93	17.74
T5	NHRDF Red	189.02	40.68	3.58	14.61
T6	Pusa Red	280.26	55.14	4.11	16.8
T7	Pusa Madhavi	224.84	46.7	3.97	15.7
T8	Arka Kalyan	248.37	48.36	3.75	17.29
T9	Arka Pragathi	216.99	37.7	3.7	12.54
T10	Arka Bindu	135.16	27.16	2.49	13.32
T11	Arka Niketan	281.57	49.29	4.13	16
T12	N-53 (Control)	244.44	52.55	3.95	15.86
CD at 5%		81.83	16.85	0.39	2.16
	Standard Error of mean (SEM) =19.50384577 Critical Difference (CD) =SEM X t % (44) =39.42				

Among all twelve varieties Agrifound Dark Red was superior in terms of average Bulb yield that is 284.44 q/ha and it is due to less post-harvest loss. Similarly, the study revels Pusa Red superior in terms average single bulb weight that is 55.14 gm/bulb & Arka niketan variety of onion acquire maximum average bulb length that is 4.13 cm

Table 4: Effect of integrated weed management on dry matter weight of weeds at 75 DAT (g/m2) in onion variety N-53

Treatment	Treatments details	Dry matter weight of weeds at 75 DAT (g/m2)					Total (g/m2)	Average (g/m2)
		R1	R2	R3	R4	R5		
T1	Three HW at 20, 40 and 60 DAT	32.1	32.5	33.8	31.4	32.7	162.5	32.5
T2	One HW at 20 DAT	73.6	73.8	74.4	74.1	73.6	369.5	73.9
T3	Pendimethalin @ 1.0 kg/ha (PPI)	74.5	76.2	73.4	71.7	75.2	371	74.2
T4	Oxyfluorfen @ 0.250 kg/ha (PoE)	78	78	77	78	81	392	78.4
T5	Pendimethalin @ 1.0 kg/ha (PPI) + one HW at 40 DAT	55.5	56.1	57.3	54.4	56.7	280	56
T6	Oxyfluorfen @ 0.250 kg/ha (PoE) + one HW at 40 DAT	52.2	51.4	54.3	52.7	50.4	261	52.2
T7	Pendimethalin @ 1.0 kg/ha (PPI) + oxyfluorfen @ 0.250 kg/ha (PoE)	57.8	60.2	58.5	59.4	58.6	294.5	58.9
T8	Pendimethalin @ 1.0 kg/ha (PPI) + oxyfluorfen @ 0.250 kg/ha (PoE) + one HW at 40 DAT	38.5	37.8	37.6	40.2	40.4	194.5	38.9
T9	One HW at 20 DAT + Ridge & furrow making (6"X6" = BXH)	26.7	27.2	26.5	28.3	27.5	136.2	27.24
T10	Weedy check (Control)	158.2	158.3	158.7	157.9	154.85	787.95	157.59
Total		647.1	651.5	651.5	648.1	650.95	3249.15	649.83
Standard Error of mean (SEM) = 19.50 Critical Difference (CD) = 39.42 Significant								

The table observation resulted high dry matter weight of weeds in weedy check that is T10 157.59 (g/m^2) followed with T4 78.4 (g/m^2), T3 74.2 (g/m^2), T2 73.9 (g/m^2), T7 58.9 (g/m^2), T5 56 (g/m^2), T6 52.2 (g/m^2), T8 38.9 (g/m^2), T1 32.5 (g/m^2) & T9 27.24 (g/m^2).

Table 5: Effect of integrated weed management on Weed control efficiency at 75 DAT (%) in onion variety N-53

Treatment	Treatments details	Dry matter weight of weeds at 75 DAT (g/m2)	Weed control efficiency at 75 DAT (%)
T1	Three HW at 20, 40 and 60 DAT	32.5	79.37686401
T2	One HW at 20 DAT	73.9	53.10616156
T3	Pendimethalin @ 1.0 kg/ha (PPI)	74.2	52.91579415
T4	Oxyfluorfen @ 0.250 kg/ha (PoE)	78.4	50.25065042
T5	Pendimethalin @ 1.0 kg/ha (PPI) + one HW at 40 DAT	56	64.4647503
T6	Oxyfluorfen @ 0.250 kg/ha (PoE) + one HW at 40 DAT	52.2	66.87607082
T7	Pendimethalin @ 1.0 kg/ha (PPI) + oxyfluorfen @ 0.250 kg/ha (PoE)	58.9	62.62453201
T8	Pendimethalin @ 1.0 kg/ha (PPI) + oxyfluorfen @ 0.250 kg/ha (PoE) + one HW at 40 DAT	38.9	75.31569262
T9	One HW at 20 DAT + Ridge & furrow making (6"X6" = BXH)	27.24	82.71463925
T10	Weedy check (Control)	157.59	0
Total		649.83	587.6451551
Average		64.983	58.76451551
	AVERAGE DEVIATION = 15.75709119		

The table observation resulted high weed control efficiency (%) in treatment T9 followed by T1, T8, T6, T5, T7, T2, T3, T4 & T10 is weedy check (control). As per table observation average deviation of 15.75 was observed.

Cost effectiveness of Onion both Traditional & Chemical farming: Observations / analysis results a BC ratio of 1:1.97 by adopting organic onion production & BC ratio of 1:1.86 by chemically onion production. Whereas an added cost of Rs. 2.17 / Kg. of Onion for packaging, loading & unloading, transportation, handling charges etc are include in total cost of production to marketing. Apart from this for onion exporting an export charges along with quality analysis cost are includes. From the results obtained Organic onions are cost effective.

Table 6

Cost of Onion cultivation (in Rs /ha)					
Sl. No.	**Particulars**	**Organic**	**Conventional**	**Total**	**Average**
1	Fixed Cost	8562	8562	17124	8562
2	Variable Cost	57895	55643	113538	56769
3	Cost of Cultivation (CostA1)	66458	64206	130664	65332
4	Gross Income	262260	240000	502260	251130
5	Net Income	195802	175794	371596	185798
Total		590977	544205	1135182	567591
Average of each component cost		118195.4	108841	227036.4	113518.2
BC Ratio Organic =	1.973140729				
BC Ratio Conventional =	1.868998762				

Seasonality in onion arrivals & prices in Indian markets

Market wise highest & lowest onion arrivals & it was observed that mostly in Delhi, Kolkata, Ahmadabad, Hyderabad, Chennai, Bangalore, Mumbai, Pune, Ahmednagar, Lasalgaon, Pimpalgaon, Yeola & Sangamner market highest onion arrival is in November to January & frequently in March to Yeola & Sangamner markets. Whereas lowest arrival recorded in January, March, April, September, October and December.

Wholesale & Retail Price of Onion in Country during experiment period.

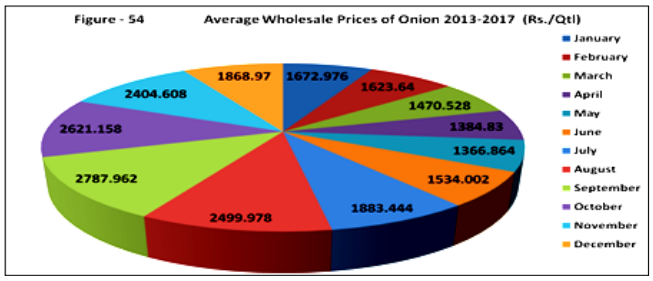

Fig 5

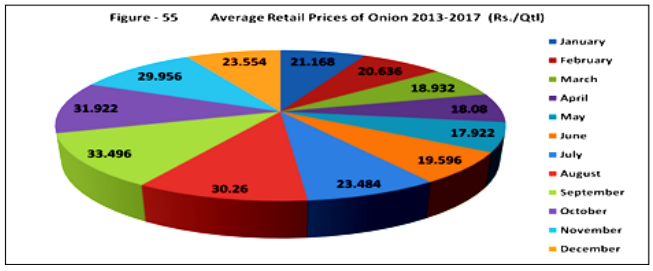

Fig 6

Supply chain Management & Digitalization of Onion

Illustrate the location specific market points at experimental State where produced onion are sailing. District / RMC wise points are useful information's for onion channel partners. A study on onion E-trading / Web base trading was conducted by sample survey with the following traders & experts. Email marketing is the act of sending a commercial message, typically to a group of people, using email. In its broadest sense, every email sent to a potential or current customer could be considered email marketing. It usually involves using email to send advertisements, request business, or solicit sales or donations, and is meant to build loyalty, trust, or brand awareness. Marketing emails can be sent to a purchased lead list or a current customer database. The term usually refers to sending email messages with the purpose of enhancing a merchant's relationship with current or previous customers, encouraging customer loyalty and repeat business, acquiring new customers or convincing current customers to purchase something immediately, and sharing third-party ads. (https://www.researchgate.net/publication/341867659_Table_graphs_PhD_Thesis_of_Dr_Sidhartha_Kar_Thesis_supporting_documentspdf)

A new innovative model was also developed during the experiment which shows holistic approaches of onion problem analysis to grass root label marketing. Mostly from research, problem analysis wise attempts, farmers production, marketing, storage, processing/ grading/ packaging/ standardization, Export to consumer countries, Indian marketing channels from producer to consumers relationships are main parts of this model.

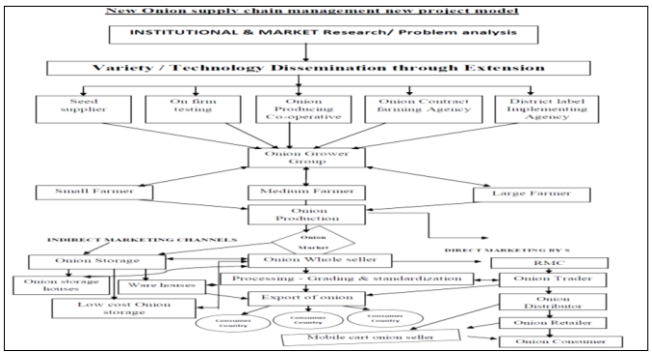

Fig 7

Conclusion

The results & discussion of the study it is concluded that among two zones selected such as eastern coastal plateau zone & mid central table land zone, Mid central table land

zone found most suitable for onion farming and fulfilling all most all farming requirements.

Effect of organic nutrient and botanical pesticides on onion applied, the best onion varieties response to vermi compost (50%) that is 2 t/ha + NPK (50:50:50) 50 Kg each / ha was remarkable and best organic treatment.

Effect of cultivation of different onion varieties found best results with onion variety Agri found Dark Red which has got best results in concern to growth & yield of onion.

Effect of integrated weed management on weed density, Dry matter weight of weeds & weed control efficiency found best results with weed control treatment one hand weeding at 20 Days After Transplanting + Ridge & furrow making (6" X 6") length X breadth in onion variety N-53.

After data analysis experimental State found best in progress with onion infrastructure development for processing of onion, onion storage structures & market development in last three year is concern it is utmost in concern with the agro ecological situations.

Experimental Country was found best in fulfilling the annual production & demand of onion, onion cultivation area, production & export of onion by excellent in designing of description about grading, standardization parameters & bulb produced in experimental field as well as in different agro climatic situations are found best to face the global requirements.

Market survey found best results with variation within experimental period of time analysis found Bhubaneswar has lowest variations of onion price from wholesale to retail sell price. And also experimental State have best control over onion price hike during the market research & experiment year that is survey results from year 2013 – 2017.

Among all supply chain management models analyses it is concluded that onion SCM developed after survey that is a new model from research to different marketing channel partner involvement and then grass root label point coverage's prepared and samples are tested in field found best results.

E- Onion marketing & digitalization found a new & best technology to reduce marketing costs and examined during experiment founds best response among primary, secondary & tertiary stock holders.

Among different onion farming treatments integrated organic onion production technology found best economic results in comparison to conventional onion farming technology that is C:B = 1.97 (Cost Benefit ratio) & net returns are best with organic onion production technology that is Rs. 1,95,802/- (Rs/ha).

Price transmission mechanism is concerned from farmer's field to consumer points costs is concern the best minimum price transmission is found during Season I during February to July average Rs. 19.25 (Rs/q) in comparison to season II (August to January).

Recommendations

From the research, analysis & experiment find out it is recommended that integrated organic onion farming vermi compost application @ Vermi compost (50%) 2 t/ha + NPK (50:50:50) 50 Kg. Each / ha produced quality and quantity in bulb production.

Neem oil decoction @ 5 ml/ litre of water at 15, 30, 45 DAT reduce pest infestation %.

Weed controls mechanics like ridge & furrow making – One hand weeding at 20 Days After Transplanting + Ridge & furrow making (6" X 6") length X breadth in onion field give better result with highest weed control efficiency, net return & reduces cost of cultivation.

Pendimethalin @ 1.0 kg/ha (PPI) + oxyfluorfen @ 0.250 kg/ha + one hand weeding at 40 DAT reduces nos. of weeds.

Supply Chain Management in onion give optimum results with research to consumer / consumer country channels involvement & co-relations among channel partner make easier in marketing of onion bulbs.

Off season onion farming (Kharif onion) reduces the price transmission cost during zero onion cultivation periods.

Commercial farming of onion variety Agri found Dark red is recommended throughout the District's of Odisha. With response to the agro climatic condition and above expected yield is concerned Pusa red 280.26 (q/ha), N-53 244.44 (q/ha) & NHRDF Red 189.02 (q/ha) varieties are also highly suitable to the experimental District's farming situations and suitable to all onion farming District of Odisha & States of India in sandy loam to silt loam having rich in organic matters.

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