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Pattern of Stakeholders' participation in Agri-food system of Paschim Bardhhaman district, West Bengal

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Abstract
A food system generally indicates parameters like food sourcing, food handling, processing technologies, market availability and ultimately consumption pattern. Hence, it includes a number of stakeholder contribution those creates a supply chain of food. In this food system largely effected by experts intervention like demonstrations on black rice, amur fish, Shivani mustard, bio-fortified mushroom from time period of (2014-2022), along with introduction of technologies like System of Rice Intensification (SRI), paddy transplanter and pump machinery. Majority of the producers practiced mono-cropping; had their own land as asset; cultivating mostly rice, mustard, lentil and rui (fish). They used newspaper and peer-groups as their communication network. The food handlers, majority traded with main products like rice, lentil, oil-seeds and their by-products in locale market via physical delivery system. The highest storage capacity was with Food Corporation of India (25060 MT), food handlers majorly used gunny bags, poly synthetic material and loose packaging as packaging material and lastly majority used nothing for advertisement. Majority consumers included rice, fish and mustard in the diet diversity; nearly all of them had ration card, consumed mostly locally sourced fruits & vegetables and majority were over-nourished.

Keywords: Consumers, experts, food handlers, producers, stakeholders

Introduction
Food systems consists of range of actors from science, technology, data and innovation sector and their interlinked value-adding activities mainly production, aggregation, processing, distribution, consumption and disposal of food products sourcing from agriculture, forestry, fisheries and food industries along with wider economic, societal and physical environmental objectives. The sustainable food system contributes towards food security and nutrition for all in such a way that will not hinder the needs of future generation (Braun *et al.* 2022) [3]. The All India Storage capacity of Food Corporation of India and State Agencies was 802.70 lakh metric tons in 2020 and all India cold storage capacity was 36229675 metric ton in 2018. (Indiabudget.gov.in,2022). Several demonstrations and knowledge was imparted regarding DRR Dhan 45 and Chhattisgarh zinc Rice 1 which were recommended to be adopted with proper growing conditions in the State of West Bengal. These two varieties are known as bio-fortified semi-dwarf, medium duration (125 days) variety of rice. More promotions of SRI (System of Rice Intensification) and DSR (Direct Seeded Rice) were being made to multiply the productive rate of Rice in the district but still the adoption rate has been seemed to be low. The cropping intensity was expected to be increased from 121% to 160%. The income of the farmers were expected to be doubled through proper value chain functioning. Some of the growth drivers identified in the agricultural system of the district were soil reclamation, enhancing the cropping intensity with more promotion of the pulse crops, production and dissemination of quality seed material, adopting climate smart and resilient technologies in order to cope up with the several challenges of production (Krishi Vigyan Kendra Report, 2017-2020) [10].

Research Methodology
The present study was carried out in Paschim Bardhaman district of West Bengal. To identify stakeholders in this food system snowball sampling was used. Personal interview was formulated for experts and food handlers interview; Focused Group Discussion (FGD) used for data collection from producers but as customer constituted a larger sample size from dynamic population so simple random sampling with questionnaire technique was followed to

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generate necessary data for this study. For the measurement of the independent variables included in the study scoring indexes used with slight modification developed by other researchers. Variables selected in this study were listed as cropping system & pattern, nutrition sensitive agriculture, production, delivery system, nourishment indicator, feedback indicator, storage capacity, packaging materials, technology intervention, diet diversity, communication network, climatic variability, trading pattern, advertisement strategies, quality assurance, ration card possession, ICT user, assets, market interventions etc. The collected data was classified/segregated; cleaned; processed; interpreted and analyzed with frequency and percentage by segregation of several factors.

1. Results and Discussions
i. Opinion on crop production methods and interventions done by experts (n=25) (in percentage)
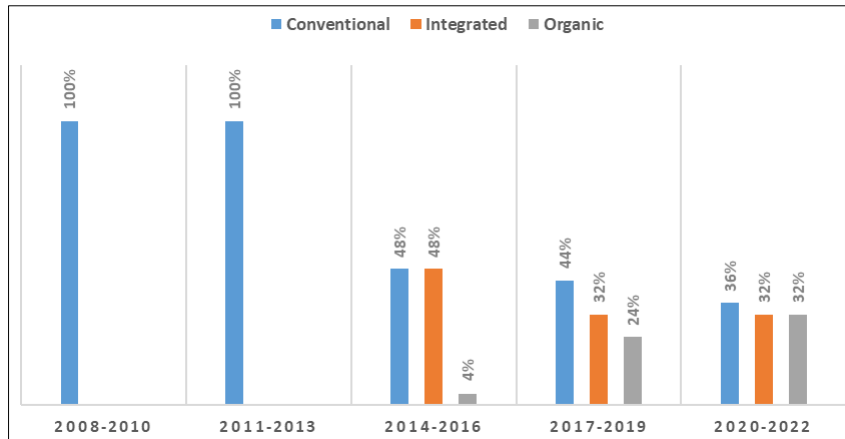

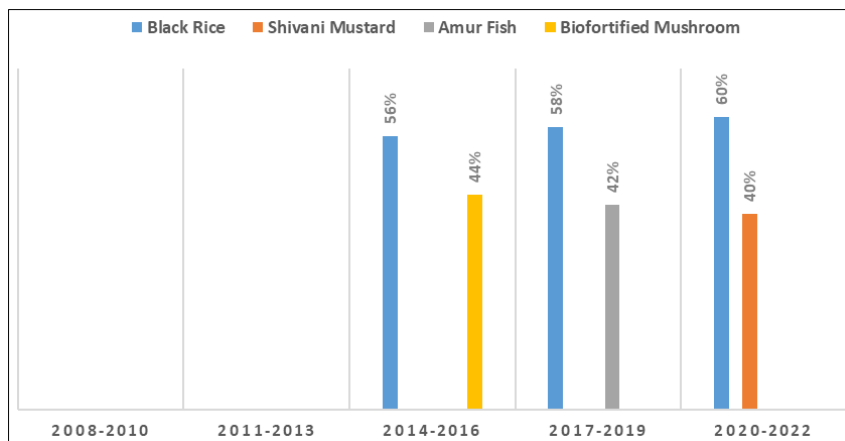**Fig 1:** System and Techniques of Crop Production (n=25)

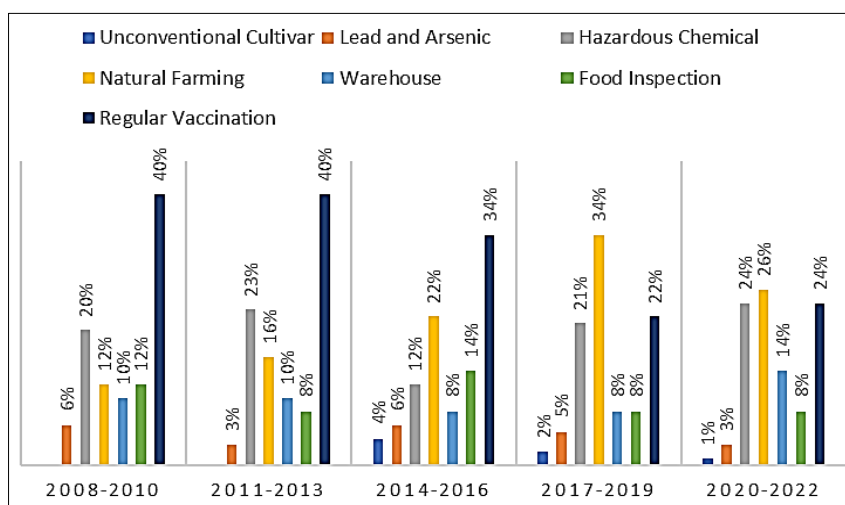**Fig 2:** Promotion of Nutrition Sensitive Agriculture (n=25)

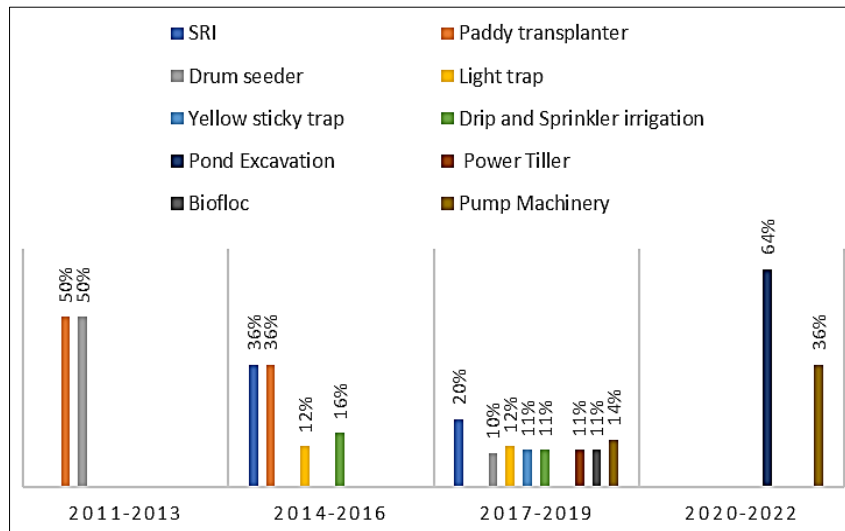**Fig 3:** Nutrition Sensitive Interventions (n=25)

Fig 4: Trend analysis of Technology Demonstration (n=25)

As per experts (in Fig 1), producers' only preference was conventional farming during 2008-2013 and then a decrease was observed. As there was an introduction of integrated farming during 2014-16 with 48 percent of adoption, followed by conventional farming (48%) and organic farming (4%). During 2017-2019, farmers preferred conventional farming (44%), integrated farming (32%) and organic farming (24%).

In the study area of Ali and Ahmad (2018) [1] indicated integrated farming with adoption of Integrated Nutrient Management and organic farming were observed. In 2020-22, preference shifted to conventional with 36 percent, followed by 32 each for integrated and organic farming.

As per expert (Fig 2) the highest promotion for crop production/ crop improvement technology (56%) was done for black rice and (44%) bio-fortified mushroom in 2014-16; followed by promotion of black rice in 2017-2019 which increased to (58%) and 42 percent promotion for amur fish; lastly during 2020-22, black rice promotion became (60%) and 40 percent for shivani mustard.

Fig 3, showed nutrition sensitive interventions implemented by experts. In 2008-22 regular vaccination of livestock decreased from 40 to 24%; avoidance of hazardous chemicals (20 to 24%); promotion of natural farming boosted from 12 to 26 percent; food inspection decreases from 12 to 8 percent; promotion of warehouse increased from 10 to 14 percent; lastly promotion of unconventional cultivar decreased from 4 to one percent (2014-2022) and lead and arsenic water testing decreased i.e., 6 to 3 percent.

Fig 4, depicted that in 2011-13 only two technology demonstrated i.e., paddy transplanter (50%), and drum seeder (50%). In 2014-16, introduction of System of Rice

Intensification (SRI) (36%), paddy trans planter (36%), light trap (12%) and drip and sprinkler irrigation (16%). In 2017-19 a number of technologies were demonstrated i.e., System of Rice Intensification (SRI) (20%), drum seeder (10%), light trap (12%), yellow sticky trap (11%), drip and sprinkler irrigation (11%), power tiller (11%), biofloc (11%), and pump machinery (14%). And in 2020-22, only pond excavation (64%) and pump machinery (36%) were the only technology demonstrated. Tawde and Banerjee (2019) [16] found SRI technique demonstrations occurred in Raniganj West Bengal, area during research time-frame.

ii. Production opinion of the Producers cum Farmers

Table 1: Percentage cropping pattern and system among Producers (n=75)

Cropping Pattern (n=75)	Mono-cropping	83
	Intercropping	17
System of farming (n=75)	Conventional	93
	Organic	7

Table 1, depicted the 83 percent of the farmers practicing mono-cropping and only 17 percentage inter cropping. Also, 93 percent of the farmers found to be engaged in conventional methods of farming and only 7 percent practicing organic methods. Majority of the farmers were found to be traditional, marginal and the major occupation of the district was depended on coal as well as paddy the major crop sown solely in the kharif season and the other seasonal vegetables were only grown as inter-crop. This result was at par with Ghosh and Chakma (2019) [7] and Ghosh and Mistri (2020) [9].

Table 2: Cultivation distribution of major crops (n=75)

Sl. No	Crops	Multiple response (F)	Percentage	Rankings
1	Rice	68	90.66	I
2	Wheat	45	60	III
3	Mustard	55	73.33	II
4	Cauliflower	33	44	VI
5	Potato	39	52	V
6	Onion	29	38.66	IX
7	Pointed gourd	16	21.33	X
8	Lentil	40	53.33	IV
9	Bengal gram	31	41.33	VIII
10	Sesamum	32	42.66	VII
11	Mango	6	8	XI

| 12 | Guava | 6 | 8 | XI |
| 13 | Litchi | 6 | 8 | XI |

Table 2, depicted the growers of different crops as per preference, where Rice got rank I; followed by Mustard rank II; Wheat rank III; Lentil rank IV; Potato rank V; Cauliflower rank VI; Sesamum rank VII; Bengal gram rank VIII; Onion IX; Pointed gourd rank X and lastly, rank XI were allotted to Guava, Litchi and Mango.

Table 3: Assets cum wealth ranking (n=75)

Sl. No	Assets	Multiple response (F)	Percentage	Ranking
1	Land	67	89.33	I
2	Tractor	9	12	IV
3	Irrigation system	5	6.66	V
4	Transportation vehicle	10	13.33	III
5	Pond	13	17.33	II

From table 3, attention was being drawn to the wealth ranking of the producers, among which land gained rank I; followed by pond rank II; transportation vehicle rank III; tractor rank IV and lastly, irrigation system gained rank V. Due to marginality, traditional behaviour and dependency on rented distribution, the above results have been observed. They were not well acquainted with modern farm machinery (as it is being counted under assets). Ghosh (2010) [6] also reported that producers were having very low amount of assets.
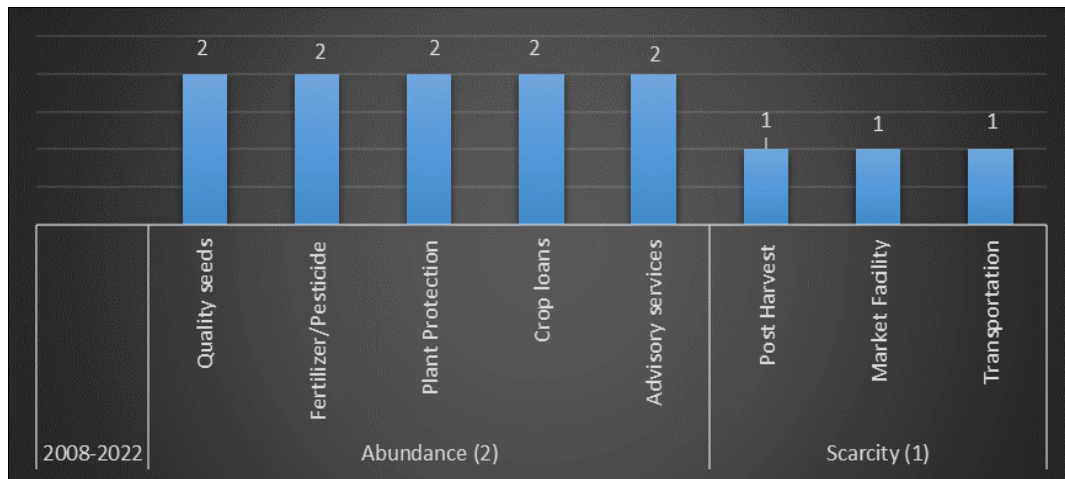

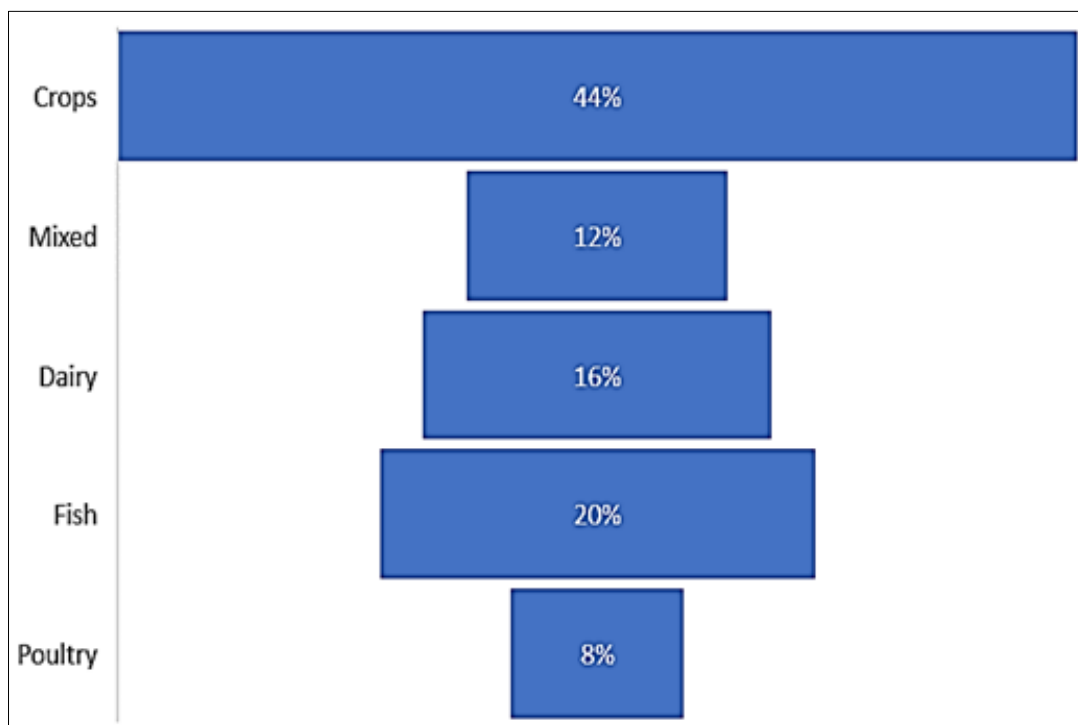**Fig 5:** Critical Factors of production (n=75)

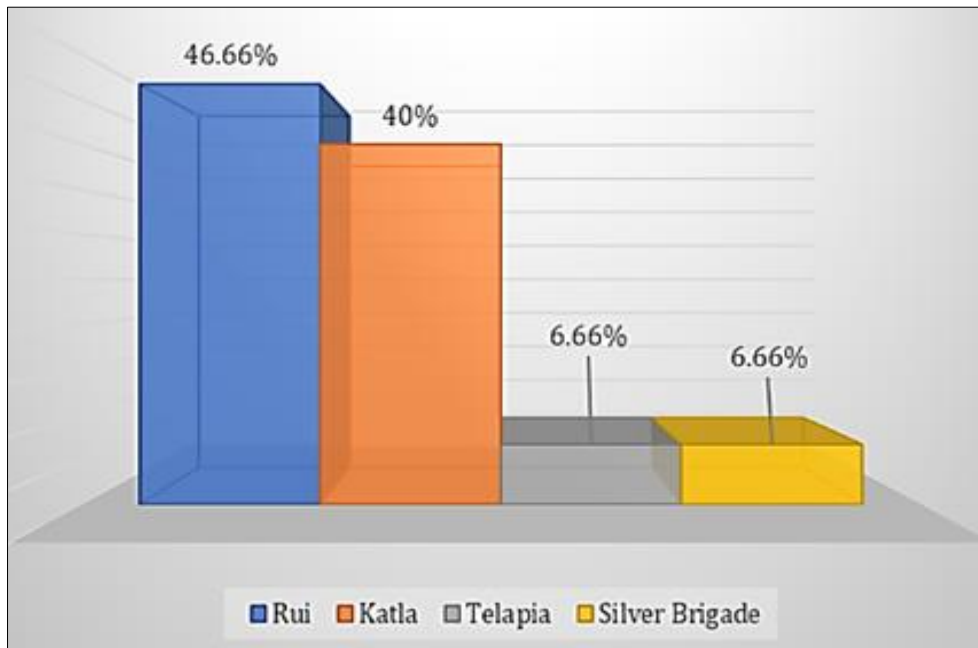**Fig 6:** Types of Producers Interviewed (n=75)

Fig 7: Fish variety (out of 20 Percent) (n=75)

It was being measured to check the sustainable factors of production and marketing in the district.Fig 5, depicted that the availability of quality seeds; fertilizers; plant protection measures; crop loans and advisory services were abundant from 2008-2022 but some gaps and scarcity was found in relation to post-harvest management; market facility and transportation. The problem of transportation was very much obvious due to increased cost and for post harvest, market facility the efficiency was still lagging in the district.

Fig 6, depicted that majority (44%) producers were sole crops growers like Rice, Wheat, Mustard, Potato, Onion, Cauliflower, Pointed Gourd, Lentil, Sesame etc.; followed by 20 percent were involved in producing/farming fish along with crops; 12 percent were mixed farmers among them i.e., growing crops along with livestock and fish farming; 16 percent were sole dairy farmers rearing mixed breed (jersey+ desi) breed; only 8 percent were sole poultry rearer.

Fig 7, depicted that out of the 20 percent production of fish (from fig 8), 46.66 percent farmers rearing Rui; 40 percent Katla; 6.66 percent Telapia and Silver Brigade. Being a fish dominated state majority of the farmers produced the common varieties of several species of fish which bought a good profit out of it. This result was at par with Paul and Chakraborty (2016) [14].

Table 4: Preference ranking of communication network (n=75)

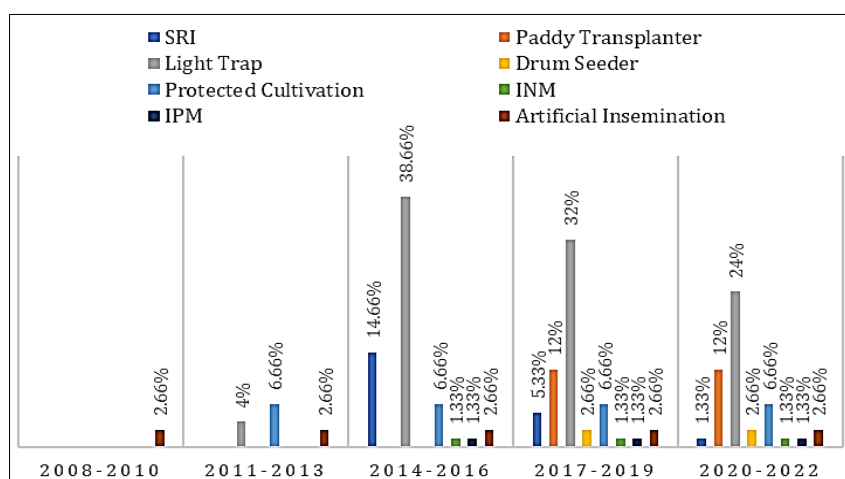| Sl. No	Communication networks	Frequency	Rankings
1	Middlemen	23	VIII
2	Mandi market forecast	60	IV
3	Website	27	VII
4	Whatsapp groups	32	V
5	Radio podcasts	29	VI
6	Newspaper	68	II
7	Peer groups	75	I
8	SMS	61	III

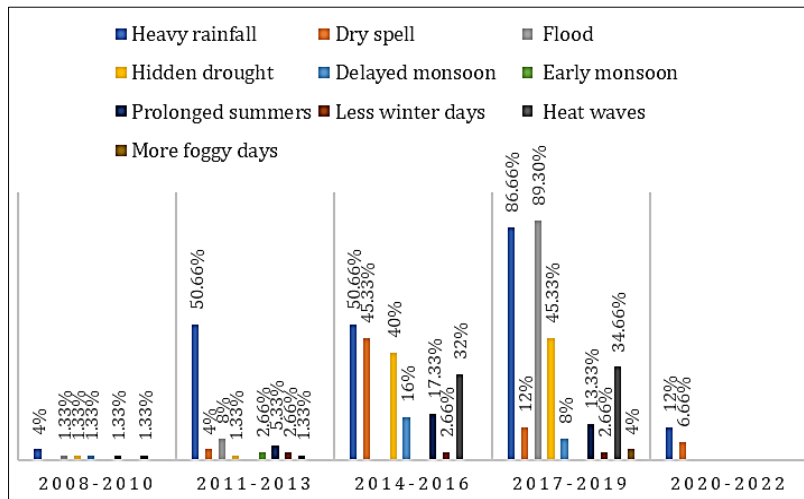**Fig 8:** Technology adoption variability among producers (n=75)

Fig 9: Trend Analysis of Climatic variability (n=75)

Table 4, indicated the preference of the farmers in the communication network, peer groups ranked I, followed by newspaper (ranked II); SMS with rank III; mandi market forecast got rank IV; whats app group got rank V; rank VI achieved by radio podcast according to the preference order; and lastly, websites secured rank VII and middlemen gained rank VIII.

Fig 8, depicted that only artificial insemination was adopted among 2.66 percent farmers consistent over the whole timeline; from 2011-2013 adoption response of light trap was achieved with 4 percent which increased to 38.66 percent in 2014-2016 indicate major hike and adoption continued till 2020-2022 but with decreasing proportion. Protected cultivation remained consistent over the whole timeline with 6.66 percent from producers; System of Rice Intensification found with 14.66 percent in 2014-2016 and continued till 2022 with decreasing proportion (1.33%) and INM and IPM maintained a low proportion of (1.33%) from 2014-2022; the adoption of paddy trans-planter and drum seeder maintained a consistent response of 12 percent and 2.66 percent respectively from 2017-2022. Similarities were found in the studies of Biswas and Roy (2018) [2] for artificial insemination in West Bengal; Chowdhury and Ray (2010) [4], found low adoption of IPM.

Fig 9, depicted that heavy rainfall got the highest response in 2008-2010 with increment to 50.66 per cent from 2011-2016 again increment found (86.66%) in the year 2017-2019 and later decreased to (12%) from 2020-2022; a major hike in flood occurrence response found from (8% to 89.30%) from 2011-2019; 45.33 percent response found for dry spell which continued till 2020-2022 in a decreasing manner along-with a response for hidden drought which majorly increased from (40% to 45.33%) from 2014-2019; response for heat waves increased from (32% to 34.66%) from 2014-2019; decreasing response was found for delayed monsoon with (16% to 12%) response from 2014-2022; early monsoon only got a minimal response of occurrence of 2.66 percent from 2011-2013 followed by major increment of prolonged summer response from (5.33% to 13.33%) over the years of 2011-2019; less winter days got a consistent response of 2.66 percent from 2011-2019 and lastly response for more foggy days occurrence only found in 2017-2019 with only 4 percent response. Results at par for flood intensity with Pal *et al.* (2021) [13].

iii. Food Handling Practices among food handlers

Table 5: Percentage of marketing techniques among food handlers (n=30)

ICT User	User	70
	Non-User	30
Quality Assurance	Assured Products	60
	Non- Assured Products	40
Feedback Collection	Collected	70
	Not Collected	30

The above table 5, depicted that majority (70%) were found to be using (Information and Communication Technology) and 30 percent not in connection with ICT tools; the certain food units opened before 1985-1995 era were in the portion of non-users. Kakkar (2020) [11] found usage of Block-chain Technology in the Rice Supply Chain Management (RSCM). Again, 60 percent of the total food handlers were found to be supplying FSSAI marked products and 40 percent not supplying FSSAI marked products portrayed the lack of knowledge of the food handlers regarding food handling rules and regulation rather carrying minimum education. Majority (70%) of food handlers collected feedback and 30 per cent didn't collect feedback.

Table 6: Marketing operations among food handlers in percentage (n=30)

Operations	Sale diversification	Multiple response (F)	Percentage	Rankings
Trading Pattern	Locale sale	30	100	I
	Inter-district sale	13	43.33	II
	Interstate sale	2	6.66	III
Delivery System	Physical	30	100	I
	Home delivery	2	6.66	II
	Online	2	6.66	II

The table 6, depicted that locale sale was practiced by all of the food handlers which attained rank I; followed by inter-district sale with rank II and lastly, interstate sale operation allotted with the least rank (III). It portrayed that the district produces a substantial amount of productivity and similar findings were reported by Ghosh *et al.* (2022) [8].

It depicted the practice of delivery system among the food handlers. Physical delivery was performed by all so it bagged rank I and lastly, home and online delivery system was ranked as II.
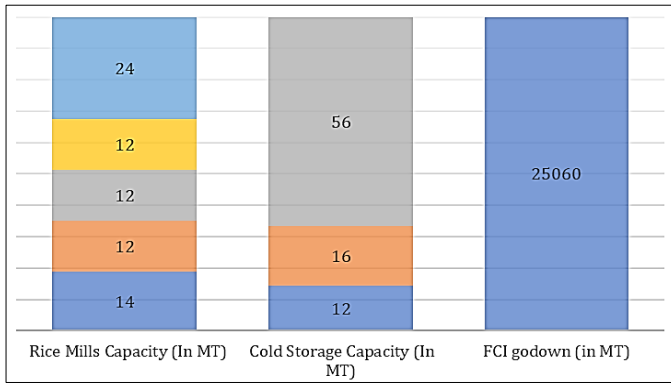
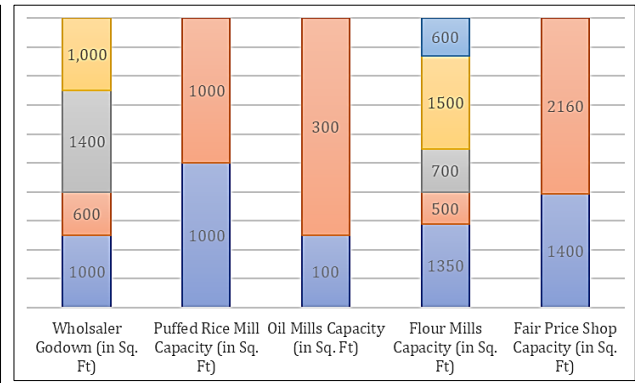**Fig 10:** Storage capacity (in Metric tonnes) (n=30)

Fig 11: Storage capacity (in Sq. Ft) (n=30)

Fig 10, depicted that the rice mills visited were having capacities of 24,12,12,12 and 14 metric tonnes; the cold storage visited were having capacities of 56, 16 and 12 metric tonnes and the Food Corporation of India (FCI) district hub was found to be having a storage capacity of 25060 metric tonnes. Fig 11, depicted that out of the total food handling units, the wholesaler go-downs were having storage capacities

of 1000, 1400, 600, 1000 sq. Ft; puffed rice mill capacity dimensions of 1000 sq. Ft; the capacity of oil mills 300 and 100 sq.ft; the capacity of flour mills were 600, 1500, 700, 500 and 1350 sq.ft and the fair price shops were having the storage capacity of 2160 and 1400 sq.ft. These food handling units found to be maintaining average capacity of warehouses.

Table 7: Distribution of main and by-products trading (n=30)

Sl. No	Products	Multiple response (F)	Rankings	Multiple response (F)	By-Products	Rankings
1	Rice	25	I	17	Rice bran oil	I
2	Wheat	5	V	5	Mustard cake	II
3	Mustard	19	II			
4	Pulses	6	IV			
5	Potato	17	III			
6	Apples	2	VI			

The table 7, depicted rice was distributed by 25 food handlers (rank I) among the whole followed by mustard being distributed by 19 food handlers (among the whole) with rank II; ranked III showed availability of potato; followed by pulses with rank IV; wheat (rank V) and lastly, apples with rank VI. In the second segment, the availability of rice bran oil (rank I) was high compared to mustard cake (rank II). Overall aspect of the table revealed the fact regarding the frequency of food handlers along-with the food availability (products and by-products) in the market of the selected district with ranking technique.

Table 8: Marketing interventions (n=30)

Sl. No	Marketing interventions	Multiple response (F)	Percentage	Rankings
1	Access to website	4	13.33	IV
2	Seasonality in business	4	13.33	IV
3	Tracking mechanism	12	40	III
4	Marketing budget	25	83.33	I
5	Marketing calender	22	73.33	II

The above table, discussed regarding the marketing interventions among the food handlers where majority performed market budgeting (rank I); among them mediocre proportion food handlers also performed market calender maintenance (rank II); followed by tracking mechanism with (rank III) and lastly, access to website and seasonality in business garnered last rank (IV). The discussion provided a glimpse of the most preferable and least preferable habits of

the food handlers.

Table 9: Market strategies in percentage (n=30)

Marketing Calendar Maintenance	Regular	46.66
	Sometime	30.01
	Never	23.33
Advertisement Strategies	Electronic	7
	Print	3
	Others	10
	Nothing	80
Market Mix	Low	63.06
	Medium	30
	High	6.94

Table 9, denoted that majority (46.66%) of food handlers were engaged in regular update of the calendar; 30.01 percent updating the calendar sometimes and 23.3 percent not in practice with updating the calendar.

Majority (80%) of food handlers did not advertise their products, 10 percent used traditional systems of advertisement; 3.0 percent took the help of print media for advertisement and 7.0 percent used electronic media.

Majority of respondents (63.06%) had low market mix score; followed by 30 percent had medium score and lastly, only 6.94 percent had very high market mix score. It showed that majority of the food handlers found to be performing inefficiently and unsatisfactorily in the food chain and thus, high percent of members needed to be more efficient as a stakeholder in the chain.
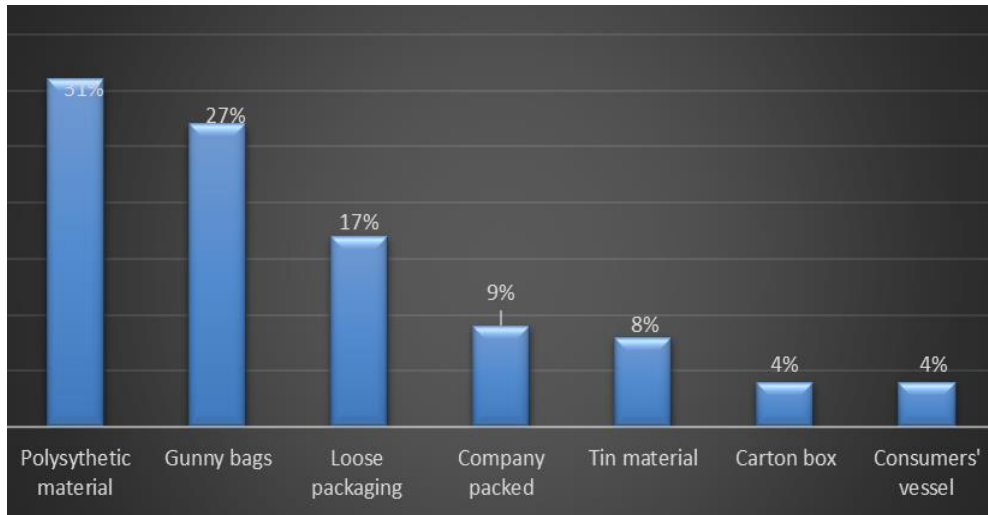
Fig 12: Materials used for Packaging (n=30)

Fig 12, depicted that 31 percent used poly synthetic materials; 27 percent uses gunny bags; 17 percent loose packaging; 9 percent company packed products; 8 percent supplies in tin material 4 percent each of food handlers used carton box and use consumer's vessels.

IV. Consumer behaviour of the identified food system (n=100)

Table 10: Preference ranking of meals consumed day before data collection (n=100)

Sl. No	Food categories	Food items	Frequency and%	Rankings
1	Cereals	Rice	75	I
		Wheat	25	II
2	Pulses	Arhar	50	I
		Moong	35	II
3	Protein	Masoor	15	III
		Chicken	10	III
		Fish	45	I
		Egg	40	II
		Paneer	5	IV
4	Vegetables	Mixed Veg Curry	40	I
		Brinjal	5	V
		Potato	25	II
		Cauliflower	20	III
		Cabbage	10	IV
5	Oil	Mustard	15	II
		Refined	85	I

In table 10, the food categories has been ranked according to the food items being consumed by the consumers before the day of data collection where it is evident that under cereals-rice has been marked by 75 consumers with rank I and wheat has been marked by 25 with rank II; under pulses Arhar marked by 50, followed by moong by 35 and lastly, masoor by 15 consumers; under protein fish got marked by 45, eggs by 40, followed by chicken with 10 consumers' marking and lastly, paneer by 5 consumers. In the portion of vegetables 40 consumers ate mixed curry with rank I, 25 ate potato (Rank II), followed by cauliflower 20 with rank III, cabbage by 10 (rank IV) and brinjal 5 with rank IV. Lastly, under the oil consumed category refined oil achieved rank I followed by mustard oil with rank II.
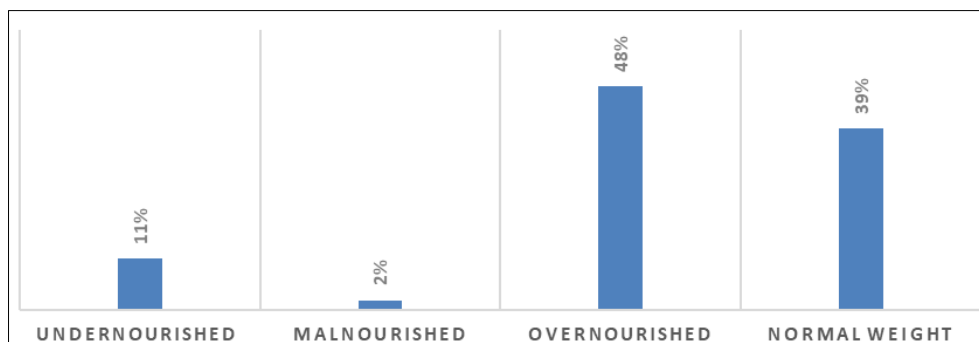

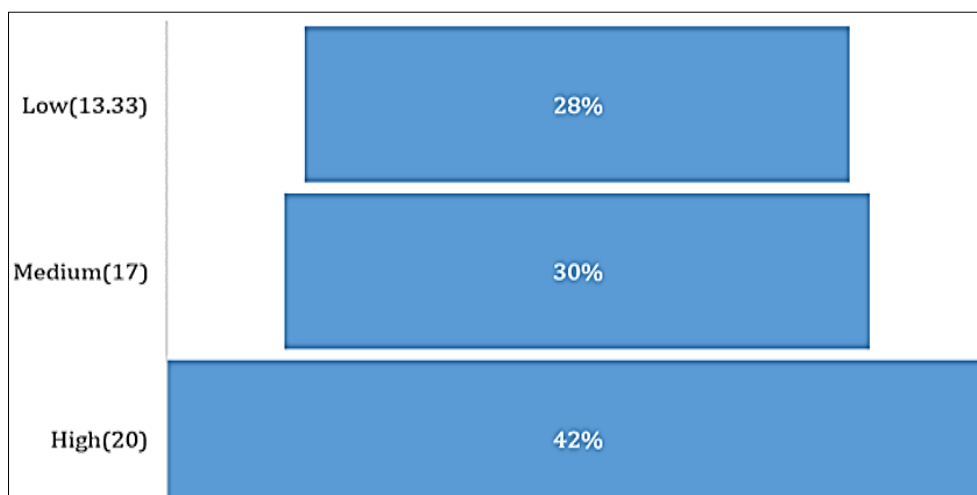**Fig 13:** Nourishment Indicator (n=100)

Fig 14: Food security status of the study area (n=100)

Fig 13, depicted the nourishment indicator of the consumers. Majority were over-nourished (48%); followed by normal weight consumers (39%), then undernourishment (11%) lastly very low proportion response found for malnourished condition (2%) among the consumers. Lahiri *et al.* (2015) [12] found more distribution of malnourishment and undernourishment with average percentage of normal weight. It was being measured in order to check the food dimensions and security status among the stakeholders.

Fig 14, depicted the score of the dimensions of National Food and Security, 42 percent achieved high score, 30 percent medium score and lastly 28 percent secured low score according to the response among the consumers in the questionnaire, which did put an insight regarding the consumer maintenance of affordability, availability, utilization and stabilization in the food system.

Conclusion
The major crop commodities being cultivated were Rice, Mustard, Sesamum, Potato, Lentil, Bengal gram, fish were Rui, Katla in a major proportion. Interventions of nutrient specific varieties had been introduced in this explored food system from 2008 to 2022 which were Black rice, Bio-fortified mushroom, Shivani mustard variety and Amur fish. Majority of the producers gave high proportion of response for System of Rice Intensification (SRI), paddy transplanter and light trap (2008-2022). Conventional farming achieved cent percent response from experts followed by integrated and organic farming along with cent percent response for mono-cropping (2008-2022) and inter-cropping initiation and then cent percent response from (2011-2022). Majority consumers included Rice, Fish and Mustard in the diet diversity and majority were over nourished.

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