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NATURE AND ROLE OF RISK AND UNCERTAINTY IN AGRICULTURE

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Uncertainty in the context of farming business has two aspects : (*i*) The state of not being definite in occurrences or results in respect of farm-firm business conduct so that parameters of probability distributions, *e.g.*, mean, variance and coefficients of variation cannot be predicted ; and (*ii*) State of uncertain mind, want of assurance or confidence on the part of the farm entrepreneur.

The first aspect covers uncertainties such as those of weather, floods, droughts, prices, pests, yield and contractual uncertainties arising from owner-tenant rights in land. The second aspect involves uncertainties of conceptual nature and form mostly a function of mental structure of farm entrepreneur.

Correspondingly, risk in agriculture has two aspects : (*i*) The chances or the hazards of a commercial loss emerging out of uncertain occurrences which can be estimated and incorporated into the structure of business as an item of cost ; and (*ii*) The conceptual apprehensions of accidental deficits and unforeseen expenses. These risks are difficult to be quantified objectively.

Both types of uncertainties create an element of risk, real or conceptual, in the business of farming. The agricultural firm is subject to most of these risks. The farmer cannot be absolutely sure of returns to decide the level of his farm expenditure

The main purpose of this study is to examine how the farmers adjust their crop acreage to the uncertainties of occurrences and make allowances for their conceptual uncertainties. More specifically, the study attempts to (*i*) establish the fact and extent of variations in the acreage of important commercial and food crops in relation to the fact of variations in yields, prices and rainfall over their growing periods ; and (*ii*) to examine the fact and extent of risk fund allowances the farmers make as a result of conceptual uncertainties.

Method and Material

The study pertains to the Ludhiana District of the Punjab. To meet the first objective, secondary data on acreage, yields, prices and rainfall over the growing periods of important commercial and food crops—wheat, gram, maize, cotton, rice, sugarcane and groundnut—were examined for their coefficients of variability and coefficients of correlation.

The observed prices and yield data expressed as a percentage of their trends also provide an evidence of element of uncertainty. Deviations from the trends were, therefore, worked out for these crops.

The acreage figures were obtained from the revenue records and the yield data from the district agricultural office. The prices were collected from the office of the market committee, Ludhiana. The rainfall data were averaged over different recording stations of the district.

To fulfil the second objective, related data on the reserve funds were obtained from a survey of 25 operational holdings. Total liquid capital available to the cultivators and the provisions for risk funds made for unforeseen expenses on the farm as well as for different crop enterprises were examined and ratios of risk fund to the total available liquid capital were worked out for existing and improved farm plans.

Results and Discussion

Starting with 1951-52 through 1960-61, data on the actual crop acreage, average yields per acre, harvest prices and rainfall over the growing periods in respect of major crops, *viz.*, wheat and gram in *rabi* season and maize, cotton, rice, sugarcane and groundnut in the *kharif* season were collected and analysed. Coefficients of variation in acreage, yield, prices and rainfall over the growing periods of these crops are given in Table I.

TABLE I—COEFFICIENTS OF VARIATION : ACREAGE, YIELD, PRICES AND RAINFALL, DIFFERENT CROPS LUDHIANA DISTRICT : 1951-52 TO 1960-61

Crop	Coefficients of variation for			
	Crop acreage	Yield per acre	Prices per maund	Rainfall over growing period
1	2	3	4	5
Wheat	6.99	4.75	2.84	25.7
Gram	3.58	4.8	4.28	25.7
Maize	6.96	8.02	4.29	15.1
American Cotton	12.00	6.2	3.3	12.02
Desi Cotton	13.8	4.8	3.81	12.02
Rice	14.2	2.72	2.66	12.3
Sugarcane	19.4	9.18	9.5	10.7
Groundnut	9.34	8.19	4.41	9.8

The impact of various uncertainty factors can be seen from Table I. It is not one factor, but an interaction of all these and other factors and several other considerations that determine the ultimate crop-mix of the cultivator. The discussion here is limited to the relationship of these specified uncertainty factors with the variation of acreage of different crops.

Rainfall and Acreage

Uncertain rains, their quantum and scatter affected the acreage of certain crops such as maize and cotton. Table I shows a high degree of coefficient of variation in respect of rainfall over the growing periods of maize and cotton crops. Although the coefficient of variation was even higher for wheat and gram, this variability did not affect the acreage under these crops, because (*i*) average rainfall during growing periods was comparatively low and (*ii*) the water requirements of these crops being not very high, one or two irrigations could make up the deficiency of inadequate rainfall. The *rabi* crop acreage was not, therefore, much affected due to uncertain rains over their growing periods.

Yield and Acreage

Yield uncertainty is one of the important factors the cultivator keeps in mind while allocating acreage to a certain crop. He might restrict the acreage under a crop which is most subject to the element of yield uncertainty. Variability in acreage of different crops in Table I, read along with the variability in the yields indicated that the variation in acreage was generally higher in those crops which experienced higher yield variability. Coefficient of correlation for yield and acreage variabilities was positive ($r = .2$), but it was not significant.

Prices and Acreage

Price variations also affected farmers' decisions in respect of their crop combinations. Post-harvest prices are of particular interest to the cultivators when they market bulk of their produce. Certainty or otherwise of the post-harvest period prices play an important part in allocating acreage under different crops. Coefficients of variability of the prices were, therefore, examined in Table I. Coefficient of correlation between the price and acreage variabilities worked out at .76. The regression coefficient was estimated at 1.27 with a standard error of .8. This indicated that the post-harvest price uncertainty effected considerable variations in the acreage under different crops.

Index of uncertainty was also estimated by expressing observed prices and yield data on important crops as a percentage of their trend values (Table II). It was apparent from Table II that the yield uncertainty in maize was the highest, index of variability ranging from 67.71 to 158.88, resulting into a great deal of fluctuations in acreage under this crop from year to year. Sugarcane followed maize with the index of variability ranging from 73.36 to 133.54. Cotton came next with the variability index ranging from 73.68 to 129.05 for American cotton and 67.33 to 117.90 for *Desi* cotton.

The index of variability of prices around their trend showed that sugarcane (*gur*) prices experienced greatest variability ranging from 70.83 to 127.71. Maize occupied a close second position with an index of variability ranging from 80.57 to 123.02. It was apparent that *kharif* crops showed greater price variability than the *rabi* crops.

Contractual uncertainties affected land use planning and farm production rather adversely. To overcome uncertainty of right of ownership in land created by land legislation, the owners hesitated to lease out the same field to the tenant year after year. The experience of farm planning in Ludhiana IADP district

TABLE II—INDEX OF VARIABILITY : ACREAGE, YIELD AND PRICES OF DIFFERENT CROPS AROUND THEIR TREND, LUDHIANA DISTRICT: 1951-52 to 1960-61

Year	Wheat			Gram			Maize			American Cotton		
	Acreage	Yield	Price	Acreage	Yield	Price	Acreage	Yield	Price	Acreage	Yield	Price
1951-52 ..	115.68	99.14	105.15	105.97	90.34	93.76	114.27	94.80	94.79	30.30	71.64	114.23
1952-53 ..	109.18	108.92	99.79	130.05	107.55	113.96	121.87	91.75	104.91	90.42	116.85	102.47
1953-54 ..	106.05	93.54	90.72	123.83	104.41	110.54	105.80	112.45	93.25	132.76	129.05	88.00
1954-55 ..	88.18	120.70	87.87	104.94	117.56	97.08	64.05	89.33	80.57	100.27	109.14	98.74
1955-56 ..	89.78	83.93	108.92	74.19	68.15	90.84	83.78	67.71	123.02	159.46	73.68	100.00
1956-57 ..	95.09	103.36	100.87	72.15	97.26	88.26	109.48	158.88	101.57	161.54	86.19	89.31
1957-58 ..	83.93	87.21	109.63	78.50	99.17	97.28	92.67	121.76	104.35	44.62	98.35	105.33
1958-59 ..	84.35	76.39	87.00	67.74	108.37	82.87	79.99	79.82	121.11	108.31	103.75	89.16
1959-60 ..	118.53	113.48	100.58	123.48	97.90	120.10	116.47	90.12	90.36	89.93	103.85	101.81
1960-61 ..	111.67	113.60	98.91	128.00	108.42	105.61	112.98	93.40	85.62	79.41	108.63	111.27

Year	*Desi* Cotton			Rice Paddy			Sugarcane			Groundnut		
	Acreage	Yield	Price	Acreage	Yield	Price	Acreage	Yield	Price	Acreage	Yield	Price
1951-52 ..	187.19	102.03	105.17	87.95	89.16	119.79	142.58	117.93	111.11	127.58	123.86	118.82
1952-53 ..	90.30	106.27	99.75	91.44	100.71	103.09	93.79	100.62	88.81	21.36	106.50	117.19
1953-54 ..	65.07	117.90	97.05	117.20	104.19	91.84	83.48	133.54	146.96	120.04	103.29	80.54
1954-55 ..	52.16	104.28	94.49	76.61	105.18	94.04	73.14	104.73	80.48	117.55	97.88	83.67
1955-56 ..	63.75	67.33	105.49	78.40	93.48	110.00	99.76	77.64	70.83	116.35	95.61	101.01
1956-57 ..	117.18	81.94	97.23	107.08	113.71	110.79	86.01	73.36	78.95	107.75	90.10	89.06
1957-58 ..	120.22	98.00	105.80	136.26	106.85	98.04	99.78	84.01	83.48	109.67	81.58	97.46
1958-59 ..	124.12	105.67	92.59	133.91	96.01	108.80	99.96	87.04	126.51	98.61	83.29	91.91
1959-60 ..	95.53	103.01	93.91	82.83	95.00	100.96	107.87	116.67	127.71	79.80	110.04	100.12
1960-61 ..	95.07	113.67	108.77	79.21	95.70	109.52	114.66	121.50	85.88	100.84	112.30	120.19

showed that some of the tenants were not sure that they could rent in all the land they wanted on time. They, therefore, found it difficult to build up their farm plans extending over a period of even two crop seasons. Indian agrarian reforms need to be carefully examined from the standpoint of built-in stabilizers for both the owner and the tenant. If the owners were sure that their ownership rights will not be challenged, they might be more willing to lease out land for longer periods, thereby ensuring better exploitation of such lands.

Agricultural policies, such as taxes, State trading and land acquisition programmes can also create uncertainties that are responsible for irrational resource-use on land. It is, therefore, necessary that instruments of agricultural policy provide built-in stabilizers that minimise the element of uncertainty in a dynamic context and help the operators take rational decisions.

Conceptual Uncertainty and Risk

A farmer cannot be absolutely sure of his expenses and returns from his farm enterprises or from his farm business as a whole. Whereas he tries to minimise the uncertainty and risk of returns (of occurrences and results) through shifts in acreage and combinations of his crop enterprises, he provides against the uncertainties of expenses by keeping reserve funds for unforeseen expenses. These unforeseen expenses provide for uncertain occurrences and are sometimes an outcome of conceptual uncertainties.

A study of twenty-five modal sized farms selected at random in Pakhowal Development Block of IADP district Ludhiana, Punjab, indicated that, on an average, a cultivator had Rs. 519 as liquid capital (owned as well as borrowed) for meeting the current expenses on the farm. In addition to meeting the variable cost of different crop enterprises, the farmer made reservations for unforeseen expenses[1]—risk fund (Table III). In addition to this amount of Rs. 103.78,

TABLE III—PRODUCT-MIX AND RISK-FUND : DIFFERENT CROP ENTERPRISES (AVERAGE OF 25 FARMS), PAKHOWAL DEVELOPMENT BLOCK, LUDHIANA : 1961-62.

Crop Enterprise	Average existing product-mix (acres)	Cash reserves per acre for unforeseen expenses	Total risk-fund
Kharif Season			
Maize	1.90	10.00	19.00
American Cotton	0.60	15.00	9.60
Desi Cotton	1.41	5.00	7.05
Sugarcane	0.32	16.00	5.12
Groundnut Irrigated	0.52	10.00	5.20
Groundnut Unirrigated	0.57	5.00	2.85
Fodders	2.07	2.00	4.14
Rabi Season			
Wheat Irrigated	6.51	6.00	39.06
Wheat Unirrigated	1.58	3.00	4.74
Gram	0.59	2.00	1.18
Fodders	1.46	4.00	5.84
Total			103.78

1. These data on unforeseen expenses were collected while obtaining input-output matrix, related to an "Analytical Case Study in Economics of Farm Planning" (Ph. D. Thesis by S.S. Johl).

Rs. 30 in *rabi* season and Rs. 40 in the *kharif* season were reserved to meet general unforeseen expenses in the farm. Total risk fund thus amounted to Rs. 103.78 + Rs. 70 = Rs. 173.78, which formed 33.5 per cent of the total liquid capital available to the cultivator.

The proportion of risk money increased to 42.1 per cent and 52.6 per cent with existing and improved techniques of production respectively on the improved farm plans (Table IV).

TABLE IV—PRODUCT-MIX AND RISK MONEY : DIFFERENT CROP ENTERPRISES, EXISTING AND IMPROVED TECHNIQUES OF PRODUCTION (AVERAGE OF 25 HOLDINGS), PAKHOWAL DEVELOPMENT BLOCK, LUDHIANA : 1961-62

Crop Enterprise	Existing Techniques			Improved Techniques		
	Acreage	Reserve Cash per acre	Total Risk-money	Acreage	Reserve Cash per acre	Total Risk-money
Kharif Season						
Maize	0.22	10.00	2.20	1.53	15.00	22.95
Cotton American	3.60	15.00	54.00	1.70	15.00	25.50
Sugarcane	1.08	16.00	17.28	2.49	20.00	49.80
Groundnut Irrigated	1.46	10.00	14.60	1.46	15.00	21.90
Groundnut Unirrigated	1.61	5.00	8.05	1.61	10.00	16.10
Fodders	2.07	2.00	4.14	1.82	5.00	9.10
Rabi Season						
Wheat Irrigated	4.00	6.00	24.00	3.75	10.00	37.50
Wheat Unirrigated	1.25	3.00	3.75	0.81	10.00	8.10
Gram	1.61	2.00	3.22	—	4.00	—
Fodders	1.46	5.00	7.30	2.73	5.00	12.25
Total			139.54			203.20

It was apparent from Table IV that total risk money increased with contemplated changes in the production programmes, especially with the introduction of improved techniques of production. Unduly large proportions of liquid capital are, thus, reserved and kept back by the cultivators mainly because of their conceptual uncertainties and risks. With the suggested changes in the production programmes through the process of farm planning with existing techniques or by introducing improved techniques and farm planning processes, farmers' apprehensions of unforeseen expenses (risk money) increased at a faster rate. This is of significant importance, especially when the cultivator's resources are already too limited to meet his investment requirements on the farm. The conceptual uncertainties of the cultivator have to be, therefore, toned down by demonstrating and providing him with adequate and reliable data and information on exact nature and extent of inputs and outputs of different crop enterprises, especially with the improved techniques of production desired to be introduced.

APPENDIX

MEAN VALUES AND STANDARD ERRORS : ACREAGE AND VARIOUS UNCERTAINTY FACTORS, IMPORTANT CROPS, LUDHIANA DISTRICT : 1950-51 to 1960-61

Crop	Acreage		Yield per acre (lbs.)		Price per maund (Rs.)		Rainfall over growth period (Inches)	
	Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S.E.
Wheat	199217	13928	1118	53	14.39	0.41	4.66	1.20
Gram	76035	2706	841	41	14.00	0.60	4.66	1.20
Maize	72961	5080	1347	108	11.40	0.49	15.40	2.30
American Cotton	41746	5009	216	14	33.3	1.10	21.47	2.61
Desi Cotton	19543	2701	209	10	25.7	0.98	21.7	2.61
Rice	2706	386	1272	35	10.50	0.28	21.0	2.60
Sugarcane	51129	9932	3511	322	15.83	1.51	24.3	2.60
Groundnut	57988	5417	730	60	15.91	0.67	18.63	1.83