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Calculation of Agricultural Insurance Premium of Dry- Farming Wheat Product by Using Rain Index (Case Study: Dargaz City)

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Abstract- Clearly, supporting agricultural sector against compulsory and natural risk factors which are out of control of producer is necessary. Agricultural insurance, is one of the supportive strategies of this sector. Among agricultural products, wheat is one the important product, especially in terms of Economy and application. To do so, to improve efficiency of agricultural products insurance policy, different tools and innovations are used based on statistic indices that one of the most effective of them can be weather index-based agricultural products insurance. This research emphasizes one of the most pervasive risks of producing dry-farming wheat, drought, thus examined rain and wheat yield variable during statistic period from 1994-95 to 2010 -11 in Dargaz city, khorasane-Razavi province, the process of product yield change was examined during this statistic period and the effect of rain on wheat yield was analyzed by using common statistic software. To predict wheat yield, regression models were used by SPSS software, among selected regression models, only weighted regression model had enough accuracy, in which correlation between wheat yield and rain reached 98percent, while in other models, it was 73percent. Lower yield with decreased rain was calculated in this model and then, rain index was calculated in order to use in dry-farming wheat product insurance and insurance premium.

Keywords: Agricultural insurance, Rain Index, Dry-farming Wheat, Insurance Premium, Dargaz.

I. Introduction and Purpose

Weather index-based agricultural products insurance is one of the new insurance plans that has been resolved many traditional problems of insurance. One of the most important advantages of this insurance plan is resolution of problems due to unfavorable selection and moral risks. Weather index-based insurance is a unique insurance product which supports farmers against damages due to weather changes and risks (Ray, 1967). Weather index insurance acts differently, so that it is planned to counter systemic damages including drought and improper temperatures. In this kind of insurance, indemnity is paid based on climatic indices such as rain level and temperature that correlate with production highly. Evaluations are conducted individually and in terms of farm yield and indemnity is paid according to weather information based index. One marked points in weather index insurance are achieving information easily and availability of proper information weather index-based insurance is selected in terms of some reasons, resistance of this plan against destructive effects of unsuitable selections and moral risks is one of them. There is individual weather index insurance contract for each

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farmer and farmer's indemnity is paid, if target index like rain level reached certain threshold limit. Indices are created based on correlation between weather phenomena and product yield, regarding data and historical background. Index may be one of the weather scales such as rain level, temperature, humidity, wind speed and the numbers of sun days which correlate product damage and are measured by third index including Meteorological Agency. This index must be reliable and insurers and insurant cannot affect the measurement of this variable (Ruck, 1999). In weather index insurance, damage from completion is not necessary, but as soon as insurance index become more or less than the limit set in the insurance contract, indemnity is paid to the damaged farmers according to the kind of regulatory contract. Availability of long-term weather information is particularly important in planning model for weather index insurance, so, available synoptic and rain-ganging stations throughout the country and reliable long-term information is the strength for execution of this kind of insurance. For weather index. There must be suitable quantitative and qualitative information about given weather variable during contract period. For example, for rain index insurance, there must be information about average rain level, total rain volume maximum and minimum rain. New innovations in technology including availability of low-cost meteorological stations which can be set up many places and artificial satellite simulations increase the numbers of places where their weather variable can be gaged. Also, the numbers of measurable weather variable have increased. Duplicable information and improved measurement tools resulted in increased reliability of indices. Index is used to determine incidence and intensity of the incidents that are mentioned in the insurance contracts. In this kind of insurance contract, damage is not evaluated in farm and indemnity is paid based on index weather insurant damaged or not. This insurance system decreases executional costs as much as possible, the error due to moral risks and improper selection and costs of controlling these risks by insurance companies. Therefore, weather index insurance mechanism has been most widely used in the middle of 1990s through plan for guaranteeing indemnity due to disastrous natural phenomena. This mechanism was represented by reassurance companies with specific objectives and it aimed at providing so much capital for counter situations with disastrous natural phenomenon (Skees & Barnett, 1999). In Iran, much of lands are in the form of dry-farming, thus considerable portion of food production is provided through these systems. Among them, role and position of dry-farming cereals especially wheat is more obvious as compared with other products, so, the objective of this research is evaluating efficiency of weather index-based agricultural products insurance for dry-farming wheat in Dargaz City.

II. Theory and Research Background

Weather insurance implies any kind of insurance aims at compensation of damages due to unusual weather events, inaddition, this insurance refers to different kind of agricultural insurance. Flood insurance, property insurance and damage insurance are among insurances that cover damages result from storm earthquake and or natural events. Index insurance still covers weather risks (skees, 2006). Focus on weather indices in order to regulating cost of insurance premium and indemnity provides an effective tool for reducing adverse consequences of moral risks. Aziz Nasiri (2011), conducted a research, agricultural risk management by weather indices based agricultural products insurance in 2011 in which copula functions were used to measure dependence structure. Since governmental support, kind of covered risks, products plants and growth conditions are different, it is suggested that selection of suitable insurance plan regarding to the previous experiences, phonologic growth stages of the region and weather conditions were examined accurately. Spica (2011), in a study, application of weather derivatives in agriculture, a case study of barley product insurance in Southern Moravia indicated that application of meteorological data as a risk management tool for production in the regions with steady production conditions is more effective than the regions without steady production conditions. Karuaihe et al (2006), represented weather index insurance for three African countries according to three indices rain, temperature and daily temperature degree. Index insurance can be planned in terms of one index or a set of indices. They, considering weather index is one of the most important indices in agriculture, introduced weather index insurance as one of the most efficient plans. They, by determining indemnity function and utility function which are targeted by farmers, specified a set of factor affecting farmer s' demands for index insurance including base risk, risk avoidance level and overload factor of insurance premium. Miranda& Vendenov (2001), in a paper," rain index insurance of agricultural products", represented a method for planning and pricing index insurance contracts. They stated that index insurance efficiency is based on relationship between indices and product yield.

Planning and Pricing Index Insurance Contracts:
There are different methods for pricing, but, as a whole, pricing is based on targeted damage as well as overload risk (e.g. administrative costs). Therefore, generally, insurance

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premium value equals: insurance premium= risk coefficient production cost of targeted product) + administrative costs

Research Objectives: 1- Examination and promotion of using meteorological data in insurance industry of agricultural products. 2-Definition of insurance tariffs by rain data and 3-determination of weather index- base insurance rate according to regional conditions.

Research Hypotheses: 1- by using rain component, damage tariff of insurance can be evaluated. 2- Weather index- based insurance correlates atmospheric conditions andyielddirectly.

III.Materials and Methods

Dargaz city is one of the cities of northern Korasan- e- Razavi province that is placed between 29.58- 37.59 longitude and 43.37- 55.36 latitude. This city limited to Turkmenistan Republic in north, Mashhad city in east, and Chenaran and Ghoochan cities in south and Ghoochan city in west. It is 4194 km^2, 1.4% of the province. Dargaz is placed at a distance of 123 km from Ghoochan city and 258 km from Mashhad city. In the present research, the effect of rain and its fluctuations on wheat product yield as an important agricultural product of Dargaz city was examined. For this purpose, statistics of wheat product yield during 17- year

Period was examined. Data used in this research include wheat yield data and monthly rain data during years from 1996- 95 to 2010-11. Monthly rain data of Dargaz synoptic station were gathered from Khorasan- e- Razavi Meteorological Agency and dry- farming wheat yield data were collected from Agricultural Jihad Organization of this province. After obtaining monthly rain statistics of each city during statistic period and determining wheat product yield, initial statistic examination were implemented. Then, the process of product yield change during statistic period was also examined and the effect of the time of rain on wheat yield was analyzed by common statistic software. At the same time, diagrams were drawn by using the mentioned software. To achieve a yield prediction mode which is worthy to use in rain index- based product insurance, some regression models were examined that were obtained by combination of several years were estimated, but these models were eliminated because of lack of accurate prediction. Thus, regarding to the experiences of other researches in other countries, weighted estimation model was applied for predicting dry- farming wheat yield. By using this prediction model, yield reduction versus rain reduction in mm was calculated and finally, rain index was achieved. At last, rain index- based insurance premium was calculated.

IV. Results and Discussion

Diagram 1 shows changes curve of rain and dry- farming wheat yield during statistic period, changes processes of rain and yield are similar, so that wheat production increased by increased rain and vice versa.

Diagram1. Changes curve of rain and dry- farming wheat yield in Dargaz city(source: research finding)

Determination if correlation coefficient between dry-farming wheat yield and rain: Indices are created based on correlation between weather phenomenon and product yield level regarding data and historical backgrounds of farms. Index may be one of the weather scales such as rain level, temperature, humidity, wind speed and the numbers of sun days which correlate product damage and are measured by third index including Meteorological Agency. An underlying variable which is used for index insurance product must correlate income or yield of a farm in a wide geographical region (Ruck, 1999).In insurance risk management, knowledge about dependence structure between variables is highly important. There are so varied methods for measuring dependence structure between variable the most common criterion for measuring dependence structure between methods is Pearson's correlation coefficient. Correlation coefficient between yield variable and rain variable including total annual growth season rain in eight months from late October to late May and rain of each month of these eight month for each city were calculated. Summer rain was ignored because of lack of its effect on production increase. Rain has important role in dry-farming. Considering low rain level in Iran, dry-farming has been long used (Sarmadnia and Koochaki, 1987). Rain level has more effect on agricultural products than other climatic elements and factors(Hoogenboom, 2000). The previous studies medicate the fact that in addition to annual rain, monthly rain distribution especially rain during growth period are great important for dry-farming wheat(Sarmadnia and Koochaki, 1987). Several researches have proved that rain is one of the most important climatic element affecting farming operation in agriculture (Azizi and Yar Ahmadi, 2003). So, its fluctuations and thus, to examine dry-farming product, monthly and annual rain levels of each station in the city were analyzed by correlation tests and Pearson's coefficient and results can be discussed as follow. The results of studies indicated that correlation between yield level and rain in different months of the year that was calculated by Pearson's method(shown in table1) implying the lowest correlation level in late September- October with negative value. Correlation between production and rain in month late March- April and May in Dargaz are high indicating rain in spring is so important in production increase. In late May- June, there is

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significant correlation between rain and yield. Difference in correlation between yield and monthly rain in Dargaz indicates thatrain fluctuation and its transmittal in every region has different effect on production level, thus, rain index estimation of every region is calculated separately regarding the date of planting wheat and phonological stages.

Table1.correlation coefficient between rain and dry-farming wheat yield data

Station Name	Total annual rain	Total Growth Season Rain(from Late October-November to late May-June	Rain in late September-October	Rain in late October-November	Rain in late November-December	Rain in late December-January	Rain in late January-February	Rain in late February-march	Rain in late March-April	Rain in late April-May	Rain in late May-June
Dargaz	0/341	0/355	-0/509*	0/064	0/180	0/482*	-0/116	0/094	0/104	0/519*	0/241

*Significance level 0.05 ** Significance level 0.01 Source: Research findings

Prediction of wheat yield by regression models: In this research, to predict yield decrease with rain decrease, different regression models were used. Results obtained from product estimation by using these models indicate that, in model in which aggregate rain was used as independent variable. Correlation between rain variable and yield variable reaches to 73 percent, yet it is not enough to estimate damage due to rain. Therefore, weighted regression model was applied to predict yield. In this model, in addition to rain level and its transmittal in estimating yield, for every month of the year which is more important in yield increase, so more coefficient is considered that correlation between rain and dry-farming wheat yield reached 98 percent and wheat production was predicted in more accurate manner (Diagram2).

Diagram2- comparison real yield with predicated yield by weighted regression model in Dargaz station (source: Research findings)

Calculation of insurance premium in Dargaz city: In the previous discussions, by using rain data, yield decrease and increase were estimated. Damage incidence threshold refers to when beneficiary incurred damage. Thus, considering the previous matters and linear diagram of this city indicating direct relationship between dry-farming yield and rain data related to growth season of dry-farming wheat, yield increases with rain increase in the growth season of product and vice versa. Insurance premium can be calculated by formula 1. Regarding estimation formula, we determine average rain level in give month, now considering rain level and that increase or decrease per mm has effect on yield and is calculable, different rain threshold and specific insurance premium can be obtained with regard to yield.

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Table2. Weighted regression model summary in Dargaz.

Model Summary	
Correlation coefficient	0/980
Determination coefficient	0/960
Adapted Determination coefficient	0/920
Standard Error Estimation	5/534E3

(Source: Research findings)

Table3- Calculation of yield and rain based on risk conditions in Dargaz

Rain percentage in 6 month affecting dry- farming wheat yield and production			
		Damage Threshold yield(kg-Hectare)	Diagram Threshold Rain(mm)
N	Total Number	17	17
	Missed Data	0	0
Average		608.0753	252.6176
Minimum		68.57	98.30
Maximum		1400.00	443.60
Risk Coefficient percentage	5	68.5700	98.3000
	10	84.3060	126.7000
	20	280.0000	187.8800
	25	285.0550	200.2000
	30	306.0660	214.2800
	40	420.0000	222.9600
	50	600.0000	242.3000
	60	754.0000	264.1200
	70	798.1440	273.7400
	80	890.0000	325.8600
	85	1025.0000	354.7500
	90	1240.0000	408.6400
	95	1400.0000	443.6000
	100	1400.0000	443.6000

(Source: Research Findings)

Regarding the above and table3, for example, insurance premium in rain threshold 187mm with 280 kg per hectare can be occurred by 20% risk, thus, the following formula can be defined for threshold of this production.

Insurance premium: Risk coefficient + (%). production cost of wheat per hectare(Riyals) + administrative = 20%. 1200000 + 240000

For other rain threshold, other choices can be made. Insurance premium, considering each risk coefficient from 5 to 100 percent yield and damage threshold rain can be calculated by above method and table3.5. Conclusions and suggestions. The present research that its total 24 results are represented following, can be considered as a small step in this regard. Examination of the results indicates that. Using weighted regression model is suitable to predict yield, because in this model, in addition to rain level and its transmittal in estimating production level by using meteorological data, for every month of the year which is more important in yield insurance, so more coefficient is considered that, correlation between rain and dry-farming wheat yield of Dargaz reaches 98 percent. Wheat production is calculated in more accurate manner by this model. To determine damage threshold level refers to rain level, less than it (in mm) maybe result in farmer's product damage, thus, insurer must compensate the damage. For example, if the measured rain is less than the threshold, farmer (insurant) receives fixed amount from insurer according to less rain level than the threshold per mm. Critical level reflects a rain level, less than it maybe result in complete damage or maximum destruction of product and farmer (insurant) can receive maximum damage compensation (equals insured product amount). According to calculations, their data were represented in table 3, rain level in Dargaz which was considered as weather index, equals 600 mm of damage threshold, less than it maybe leads to damage and 68.5 mm is critical threshold, less than it approximately equal complete destruction of product.

It is suggested that weather index insurance planning represents based on only one weather index. Meaningly, index kind is selected regarding target region, kind of product and suitable weather condition. To specify weather index insurance, determination of limit value and rain threshold are so important. For this purpose, it is recommended that related agencies like Meteorological Agency, prepare accurate rain level, limit value and rain threshold monthly and give them to farmers and insurance funds.

Pilot model or contracts' drafts should be planned for certain meteorological agencies and customers. Trend and process of this plan, finally must be targeted in a manner that is an accurate aspect and index of customers' risks. In addition, it should regulate and consider an insurance premium which customers capable of its payment.

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