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PREDICTION OF PRICES FOR AGRICULTURAL PRODUCTS THROUGH MARKOV CHAIN MODEL.

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Abstract---*Currently all producing meet to with face to big problems as the determining production volumes because they have a problem related to predicting the consumer prices in the future. In fact, the consumer prices are strongly fluctuations in the market due to these related to directly seasonable. Many developing countries have already done this problem, as like these countries used to many methods to forecast agricultural production volumes and prices. Producing agricultural products are related to many causes including natural factors and the scientists results also influence to prediction of total volumes. Nowadays, the scientists and researchers are using many factors to forecast of changeable prices in the future. While using many methods have not taken good results, because the production of agricultural goods prices also is directly connecting to times factor, so using the Markov Chain model is more efficiently to prediction price in the future. Production commodities are related to many factors on the agricultural sector, so that the price of goods may be strongly change on short time what is rise, down or unchanged. One must not forget that It is important to analyze each case and select an alternative to the benefit of all subjects which also are producers, intermediaries and consumers.*

Keywords---CHAIN MODEL, PREDICTION OF PRICES ,AGRICULTURAL PRODUCTS.

I. Introduction.

Development of the republic economy and ensuring food safety are directly dependent on agriculture. Let's take note of GDP that the production of agricultural volumes is larger than other sectors which it shares of 32 % on GDP, accordingly we can say that the agricultural sector is the most important to our republic economy. At the same time, accounting to large part of people live in the countryside that their lifestyle is also related to agricultural desk. The big part of population is producing agricultural commodities on their household so like these population is influencing market prices in the future. Actually, many household farms independently decided as what type of plants are cultivated as a result predicting total of volumes products are more difficulty. It is worth noting that the climate also is not same to all regions, while all producers are spending same expenditure, but their fertilities are different, as a result a type of farms are able to more income to using natural factors than others. at the same time our country farms have years of experiences to cultivating plants in addition they have the deepest knowledge to soil fertility, so these opportunities give to production all agricultural goods. However, there are several factors affect to market prices due to large number of manufacturers on the agricultural. First of all, all household are producing a

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little part of goods, but they using more natural factors. Secondly, producing agricultural goods are strongly dependent to climate hence the biggest part of producers is able to make only seasonable so the volumes of supply also is strongly fluctuations on season. Surely, this phenomenon affects to the consumer prices of the market. In addition, there are such other factors to influence to total of volumes production what are the creation new varieties plants, invention new technologies to cultivate plants. Nowadays, lack of marketing system researches on the agricultural markets in addition no any organization to under researches of consumers prices is one the biggest problems to consist of consumer prices in the market. According to the research show that the cultivation plants is related to annual rainfall so the total fertility is also directly connecting with yearly precipitation. Consequence the consumers price also is related to this issues. As a matter of fact, initially all consumers buy food and then they want to other goods. However, one of the main tasks of agricultural marketing is to ensure that agricultural commodities are sold at acceptable prices. At the same time, agricultural goods are strongly different of industry commodities. First of all, there is a number of little producers so like these households are not able to do more attention to marketing researchers and advertisement of products. Although there is little focus on advertising to agricultural products in this days, but do not forget that the creation of commodities brand is more efficiently in the future. The brand goods are bought by consumers with the most prefer. Our agrarian sector has also been reformed by the government since 1991, at this time the market laws have acted in our agricultural market, in addition the government order also cancelled at that time. However, there was a problem related to run of the consumer prices at that time. It should be noted that this problem has not been fully resolved on this time. This phenomenon especially problematic for both the producers and consumers. Although there has been conserved a sharply fluctuation prices on the consumer markets, but the government has been performed to resolved reasonable prices. Consequence, there has been achieved to run on the consumer prices, but do not forget that the market prices are not able to controlled by government decisions.

In 18.11.2016 the president of the republic of Uzbekistan made decision over the number of PP-2492 that "Uzbekozikovqatholding" was established. this organization has identified several tasks including marketing were research related to the producing agricultural goods and consumer prices. while studying and researching producing of agricultural commodities and entering to new foreign markets and learned their requirements and like these missions are the first task on this company. However, marketing research is difficult because of the large number of manufacturers at the same time they do not member of any cooperatives on the time in addition the prediction consumer prices are insufficient focus on these days.

In our opinion, it is possible to achieve the mutual compatibility of consumer market prices by the ensuring interoperability some issues which are production, storage, transportation and sales processes in addition legalization of intermediary activities also are more efficiently to achieve in regulating market prices. The researching is showed that only 45-50 percent consumers prices are consisted by households and farms. Hence, the formalization of intermediary activities enables to the prediction on relatively consumer market prices. At the same time, access to information on the size of private and government warehouses and stored products and enhancing the role of contractual relations in the sale of goods will also allow to manage market prices, because the total volumes commodities might be to determined by this method.

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Generally, while few types of partially production are made by the greenhouses during on the year, but several types of agricultural plants are the seasonal in our country. However, not all type of products can be cultivated in greenhouses, because it is related to both more financial resources and higher knowledge personnel. As we note that the higher share of the private sector than government sector in the total output, accordingly this process is able to managed to only economic mechanisms. currently many researchers use to several methods to prediction consumer prices, but in our means that the Markov chain model is also more effectiveness for forecasting of consumer prices.

II. Literature review

Recently, Markov chain model is widely used on many economic processes forecasting. In particular, the Markova chain model is used by the Chinese researchers who were Zhang and their groups. they had been forecasted stock market analysis by this method. Lately, the Markova chain model is used by the Chinese researchers who were Zhang and their groups. They had been forecasted stock market analysis by this method[2]. At the same time, Oriento has been used the Markov chain methods. his research has also related to prediction future stock market prices[3]. Zhu and Xu also have applied on the Markov Chain method and they also achieved good results as forecasting vegetable prices[4].These researchers were analyzed the changes of the vegetable prices by social survey and monograph observation and forecasting on the market prices by the using Markov chain models was over the certain period of time. Another Asian researcher who was Jsinkhan had utilized on this method as his researches and his conducted research also related to predict vegetable prices in Sri Lanka's agricultural market[5]. they have been based on monographic observations of fluctuations prices on the agricultural markets and their means of that the rapidly fluctuations price has been noted base period.

The goals of research - using the Markov sandbox model for forecasting the prices of agricultural produce grown for the free market and forecasting the future prices for products.

III. Research methodology

The Markov chain model has used to analyze for consumer market of changing prices in the future. The research results have been based on monographic observations, social surveys and date ministry of aquiculture and the State statistic committee of the republic of Uzbekistan and forecasting was the potatoes prices.Daily price fluctuations at the agricultural goods market has been based on researching observations and the state statistic committee of the republic of Uzbekistan. Markov chain model is that it is a stochastic analysis of economic processes under the time factor.(X_n), $n = 0, 1, 2$ ...discrete random events are considered to be repeated over a given time interval (C) and calculated by the Markov chain model.

On Markov point of views:

Every i, j, i_1, i_2 … i_{n-1} S

[2]*Zhang.D&Zhang.X (2009). "Study on forecasting the Stock market trend based on Stochastic analysis method". International Journal of business and management. Vol.4, No.6June2009.*
[33]*Otiento.S, Otumba.E&Nyabwanga.R.N. (2015). "Application of Markov Chain to model and forecast Stock market trend". International journal of Current Research Vol. 7, issue, 04, pp.14712, April, 2015.*
[4]*Zhu.X and Xu.X. (2012). "Markov Chain analysis and prediction on the fluctuation cycle of vegetable price". Journal of System and management Science ISSN 1816-6075 (Print), 1818-0523 (Online), Vol. 2(2012) No.3, pp.40-49*
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$P_r\{x_{n+1} = j|x_n = i, x_{n-1} = i_{n-1}, x_1 = i, x_0 = i_0\} = P_r\{x_{n+1} = j|x_n = i\}$ (1)

If P_ij = P_r {x_ (n 1) = j ├ | x_n = i┤ }, the process changes from position i to n, we are able to consider the variation j (n 1) a one-step probability of the Markov Chain model.The probability of these one-step processes do not depend on the time (n), then a stationary Markov chain can be used. That is, the matrix method is used to determine the probability of changes and is expressed in the following formula.

$P = \left[P_{ij}\right]_{n*n}, 0 < P_{ij} < 1$(2)

All the results are written in the form of rows and columns as using the Markov chain model, therefore, this probability matrix is square and the sum of the rows is lonely.

The likelihood is calculated as follows:

$P_{ij}^{(k)} = P_r\{X_{n+k} = j\lfloor X_n = i\}\ \forall k > 0\ \ n \blacksquare 0, i\ j \blacksquare\ \$$ (3)

We can write that the transformation of an event from a i phase to a probability j with the following matrix:

$$P^{(k)} = \left[P_{ij}^{(k)}\right] i, j,\ S\ \forall k > 0\ \ (4)$$

That is, the change on the matrix k on phase, $P_{ij}^{(k)}$represents the change in $P^k$of the matrix (ij) elements.If the data in the chain model are at the same time, n does not depend on the chain.$P_{ij}^{(k)} = P_r\{X_k = j\lfloor X_0 = i\}\ \forall k > 0, i\ j \blacksquare\ \$$ (5)

$P_{ij}^{(1)} = P_{ij}$ ва $P^{(1)} = \left[P_{ij}^{(1)}\right]$ and all for k's $P^{(k)} = P^k$

$$P_{ij}^{(k)} = P_r\{X_{n+k} = j\lfloor X_n = i\}\ \forall k > 0\ \ n \blacksquare 0, i\ j \blacksquare\ \$$$

The probability of the equation is the k - probability that the function changes from i from position i to j at k. The matrix of this equation is as follows:

$$P^{(k)} = \left[P_{ij}^{(k)}\right] i, j, s\ \forall k > 0.\ (6)$$

That is the events to be analyzed are the same as the study time, then the Markov chain model is as follows:

$\neg^{(0)} = [P_r\{X_0 = i\}]\ i \neg S$ ва $\neg^{(n)} = [P_r\{X_0 = i\}]\ i \neg S = \left[\neg_i^{(n)}\right]\ i \neg S$Markov point of view that n denotes a time series of probabilities by this formula. In fact, the fully understanding to the matrix is more important for the initial distribution.

Using the model

We have to need to several intervals which is the knowing products prices in order to frame the model and dynamics (frequency) of change in unit of time is determined. Although each of the selected intervals is of particular importance, but they are complement several other and part of the Markov chain model. However, the daily sale price of the goods is subtracted as setting the intervals. Interval ranges are typesetting according to the same price fluctuations during the observed periods. That is the gradual change in the price of potatoes at the same time periods is considered as a step in the interval. Changing these ranges from one stage to another is a factor determining the likelihood on the Markov chain changing. Each interval of the matrix's probabilities of variation frequency has been found by dividing by the probability of total change. At the same time, the probability of fluctuation prices also has been analyzed on during the day and the probability of daily fluctuations also recorded.

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IV. Analysis and results

initially market prices are learned in addition the government reforms were also which them supported free market. In our mean, the studied on the potatoes price is more facility than other vegetables and fruits, because other agricultural products are several types besides that the potatoes are cultivate by all regions. Therefore, based on results of 2924 observations on the market prices of potatoes have studied during on the 2010 to 2018. Within this period of time, the price of potatoes has grown from 500 sums to 3,200. The price range for this interval is set at 50 sums and the frequency is calculated.

Table 1: Frequency allocation table.

observationsp	У	Frequency
1	550	12
2	618	18
3	685	13
4	753	39
5	820	190
6	888	114
7	955	140
8	1023	224
9	1090	268
10	1158	123
11	1225	87
12	1293	95
13	1360	0
14	1428	5
15	1495	19
16	1563	3
17	1630	71
18	1698	63
19	1765	23
20	1833	124
21	1900	17
22	1968	0
23	2035	9
24	2103	159
25	2170	48
26	2238	78
27	2305	13

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28	2373	194
29	2440	91
30	2508	51
31	2575	13
32	2643	290
33	2710	7
34	2778	59
35	2845	91
36	2913	59
37	2980	19
38	3048	85
39	3115	7
40	3183	3

We divide the prices of potatoes are into 7 parts in the table over the Markov chain: C1: The price of 1 kg of potatoes is less than 800 sums, that is C1 <800.

C2: 820 <kg / price <= 1160, C3: 1160 <kg / price <= 1430, C4: 1430 <kg / price <= 1840. C5: 1840 <kg / price <= 2170, C6: 2170 <kg / price <= 2450, C7: 2450 <kg / price <= 3115

Calculating of the price changes are in each interval for the specified sections.

Table 2: Potato price change matrix.

	C1	C2	C3	C4	C5	C6	C7	total
C1	265	7	0	0	0	0	0	272
C2	9	850	10	0	0	0	0	869
C3	0	11	166	10	0	0	0	187
C4	0	7	21	264	11	0	0	303
C5	0	0	7	23	198	2	0	233
C6	0	0	20	11	322	21	2	376
C7	0	0	19	21	52	589	3	684

The variance probability matrix is calculated over the ratio of the frequency on each part to the total frequency of that part. That is $p_{11} = 272/265\, p_{11} = 7/265$ .... , are calculated. The probabilities prices of potatoes are given on the 3 table.

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Table 3:The change probability matrix.

P=		G1	G2	G3	G4	G5	G6	G7	total
	G1	0,9743	0,0257	0	0	0	0	0	272
	G2	0,0104	0,9781	0,0115	0	0	0	0	869
	G3	0	0,0588	0,8877	0,0535	0	0	0	187
	G4	0	0,0231	0,0693	0,8713	0,0363	0	0	303
	G5	0	0,0129	0,0300	0,0987	0,8498	0,0086	0	233
	G6	0	0	0,0532	0,0293	0,8564	0,0559	0,0053	376
	G7	0	0	0,0278	0,0307	0,0760	0,8611	0,0044	684

An analysis of the price is changed process that it through this matrix will ensure that the primary and final data are interconnected. Therefore, the initial probability vector is as follows:

$$\Pi_{(0)} = (1\ 0\ 0\ 0\ 0\ 0\ 0)$$

Therefore, the forecasting of the next days is calculated as follow through on the Markov chain:

$\Pi_{(1)} = \Pi_{(0)} * P =$ (0,9743 0,0257 0 0 0 0 0).

According to the predict C1 interval is the highest probability so it consists of 97.5%, that is the highest price in this interval was <=820 sums/kg.This means that 97.5% current prices can be accounted by future intervals. At the same time, calculating might be considered subsequent intervals on the same order.

$$\pi_{(2)} = \pi_{(1)} * P = (0{,}8963\ \ 0{,}1027\ \ \ 0{,}0010\ \ \ 0\ \ 0\ \ 0\ \ 0)$$

According to this calculation is that the highest price is marked as selection of C1 and this is based as the percentage of current prices in C1 to predict in future changes prices. Hence the next interval is going to be 0,8963. The highest intervals of indicate is in the C7 that this average price is get on this interval to forecasting.

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Table 4: Prediction of interval.

№	days	Probability							choosing interval.	Prediction price
		C1	C2	C3	C4	C5	C6	C7		
1	3000	0,9743	0,0257	0,0000	0,0000	0,0000	0,0000	0,0000	C7	2680,0
2	3040	0,8963	0,0486	0,0551	0,0000	0,0000	0,0000	0,0000	C7	2741,4
3	3090	0,8746	0,0819	0,2488	0,0002	0,0000	0,0000	0,0000	C7	2796,2
4	3140	0,7586	0,0990	0,0990	0,0299	0,0009	0,0000	0,0000	C7	2860,2
5	3190	0,6980	0,1072	0,2116	0,0011	0,0010	0,0001	0,0000	C7	2883,7
6	3240	0,6021	0,0910	0,3050	0,0017	0,0018	0,0003	0,0000	C7	2840,7
7	3290	0,5908	0,1012	0,3488	0,0025	0,0027	0,0004	0,0000	C7	2869,7
8	3340	0,5435	0,1154	0,3382	0,0034	0,0037	0,0005	0,0000	C7	2910,4
9	3390	0,5610	0,1860	0,2271	0,0044	0,0049	0,0007	0,0000	C7	3116,2
10	3440	0,4215	0,1915	0,4016	0,0055	0,0062	0,0008	0,0000	C7	3133,4

As regards to 4th table it is visible that the price of potatoes might be higher or lower than in currently days. Noteworthy is that the fact change of price are more strongly depend on the two factors which are time and based price. In the Markov chain model is shows that each event is definitely influenced by their past and subsequent results due to directly related to each other. The probability of 3x3 matrix is calculated over the Markov chain model. According to this matrix:

S1 - the lower price of potatoes during on the observation than previous days;

S2- the higher price of potatoes during on the observation than previous days;

S3- the same price of potatoes on the observation days.

Accordingly, the 3x3's variance probability matrix has been calculated as follows.

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Table 5: Change matrix interval

	S1	S2	S3	Total
S1	92	134	220	446
S2	91	55	219	365
S3	238	184	1691	2113
Total	421	373	2130	2924

The probability matrix on the table 5 is calculated as follows:

$p_{11} = 92/446 = 0.2062; p_{22} = 136/446 = 0{,}3004; p_{33} = 220/446 = 0{,}4933;$

Table 6: The change probability matrix.

P=		S_1	S_2	S_3
	S_1	0,2063	0,3005	0,4933
	S_2	0,2493	0,1507	0,6000
	S_3	0,1126	0,0871	0,8003

Selected product, that the initial probability vector of potatoes price

$\pi_{(0)} = (\pi_1, \pi_2, \pi_1)$ is calculated as follows.

$\pi_{11} = 421/2924 = 0{,}1439, \pi_{12} = 373/2924 = 0{,}1275, \pi_{13} = 2130/2924 = 0{,}7284$

The future price might be predicted by the base of on the probability of these vectors. The probability vector will be as following days:

$\pi_1 = \pi_{(0)} * P = (0{,}0905 \;\; 0{,}0383 \;\; 0{,},3593)$And for the next days that is equal of $\pi_2 = \pi_{(1)} * P = (0{,}0358 \;\; 0{,}0192 \;\; 0{,}4370)$

So, it can be seen that the S3 is important to all occasions and at the same time, the probability change of potatoes price will be around 10 – 13 percent. If the percentage of calculation is the same which given above, that the prices have been immutably in these intervals. In fact, forecasting in the future price at the current research information's are the most complex process. At the same time, the probability of changing prices is calculated at the certain time period through the probability matrix of n - phase's. as well as the elements of the probability matrix Pn has represented at the probability price changes, because there are changes on the market prices after certain n - steps.

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Table 7: The probability of changing of P matrix.

P^3		S_1	S_2	S_3	P^4		S_1	S_2	S_3
	S_1	0,1159	0,1882	0,6959		S_1	0,1168	0,1501	0,7341
	S_2	0,1252	0,1929	0,6809		S_2	0,1116	0,1614	0,7318
	S_3	0,1165	0,1586	0,7211		S_3	0,1234	0,1594	0,7198
P^5		S_1	S_2	S_3	P^6		S_1	S_2	S_3
	S_1	0,1226	0,1476	0,7311		S_1	0,1041	0,1806	0,7217
	S_2	0,1314	0,1514	0,7216		S_2	0,1202	0,1471	0,7331
	S_3	0,1506	0,1394	0,7188		S_3	0,1146	0,152	0,7374
P^7		S_1	S_2	S_3	P^8		S_1	S_2	S_3
	S_1	0,1156	0,1692	0,7152		S_1	0,1007	0,1788	0,7451
	S_2	0,1043	0,1592	0,7376		S_2	0,1086	0,1582	0,7218
	S_3	0,1105	0,1522	0,7376		S_3	0,1011	0,1702	0,7301
P^9		S_1	S_2	S_3	P^{10}		S_1	S_2	S_3
	S_1	0,1038	0,1792	0,7178		S_1	0,1439	0,1275	0,7286
	S_2	0,1211	0,1648	0,7142		S_2	0,1439	0,1275	0,7286
	S_3	0,1028	0,1702	0,7268		S_3	0,1439	0,1275	0,7286

The elements of probability matric effect on the time factors which are given above, these are directly impacted at the probability of general price. Furthermore, at the plurality intervals have being of multicollinear that it is likely to be almost the same price of potatoes in these periods. According to the research, the potatoes prices have been changed for ten times during in the year, but the final price is longer stable than others. On the table above, S1 represents the likelihood of a fall the potatoes prices, and S2 delivers the probability of price increases. While S3 is indicated that the market prices are likely to remain unchanged. Accordingly, the consumer prices on the market do not change at this interval of 72% probability. Do not forget that there is only a time factor analyzed how it has been impacted a change of potatoes price.

We can conclude that the using of Markov chain model analysis the price fluctuations of potatoes on our location farm market and it is projected to change over time depending on consumer prices. Of course this prediction is involved to short-term, that is the forecasting is made for the 2019 year through changing on potatoes price between 2010 and 2018. At the same time, the probability of potatoes price was calculated to "decline", "growth" and "stability". In general, as compared to results the Markov chain model has given 88 percent practical value. As can be seen from table 7, the potatoes prices are going to not more change in the future. In fact, using several methods may be predicting to change on the market prices due to the large volume of production available to the markets by dehkan-farms so using Markov chain model can be given more efficient.

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