



*Original article*

## Infestation and storages in Balochistan during 2019-2020

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### Abstract

The present study was aimed to inspect the stored product insect pests from different godowns (Governmental and Private) of four districts namely Quetta, Pishin, Loralai and Sibi (two from cold and two from hot climatic regions). Insect pests damaging cereals were collected from godowns of these localities. The collections were made on a monthly basis from five (Private/Govt./Plinth) godowns of each district. All insect pests were collected during January -December 2019-2020. These samples were identified by using the standard identification keys [1-3]. *Tribolium castaneum* showed the highest increase, from 10.28% in 2019 to 13.54% in 2020. *Trogoderma granarium* also had a significant increase from 9.28% to 12.25%, followed by *Rhizopertha dominica* with an increase from 7.18% to 9.83%. *Sitophilus oryzae* showed a smaller increase from 7.18% to 8.40%, while Angoumois grain moths had the smallest increase from 1.06% to 1.59% in Sibi while least population was noticed in Quetta as *Tribolium castaneum* were found with 5.03% and increased to 7.25% in 2020. *Trogoderma granarium* from 3.80% to 5.56%, *Rhizopertha dominica* were from 2.67% to 3.48%, *Sitophilus oryzae* from 1.75% to 1.49% and *Angoumois grain moths* were collected from 0.51% to 0.41%. The collected data also reveal that in governmental godowns the population of stored product insect pests were found higher than the private godowns due to their basic facilities. The values in Sibi showed an increase from 11.74% to 16.42% in 2020 for government godowns and an increase from 6.95% to 12.30% in open areas. Private godowns had 15.34% in 2019 and increased to 16.89% in 2020. Similarly, Loralai and Pishin government godowns also showed an increase in insect pests in 2020. In contrast, Quetta government godowns had a relatively stable percentage of insect pests in 2019 and 2020, while private godowns showed an increase from 2.88% to 4.04%. The present study is the first of its kind and is helped full for the identification and prevalence of different stored product pests in different storages of Balochistan during 2019-2020 in Covid condition.

### Keywords

Insect pests, Stored grains and Infestation

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## Introduction

Balochistan province with four agroecological zones is known as the fruit basket of Pakistan because Balochistan has big economic potential and has capacity to produce rewarding crops like almonds, Pistachios, Walnuts and other fruits/ dry fruits but the cereals of Balochistan Wheat, Rice, Maize and Barley for human consumption are purchased from Sindh and Punjab to fulfill its basic nutritional needs. The climate is temperate along the coast, Inland deserts and arid zones are hot while the mountainous region is cold. There is no enduring system of irrigation here except in plains of Naseerabad district. Balochistan is faced with food uncertainty. It requires 18,000,000 metric tons of wheat annually to nourish its 12.34 million population. There are many vintage limiting factors and pests in which insects and rodents play an important role [4]. Farmers and traders both mostly use bags for storing grains for limited time period however when it is stored in plastic bags for longer periods then quantitative as well as qualitative damage occurs due to insect pest as they consume cereals and makes it unfit for human consumption. Both biotic and abiotic factors are the reason for the loss of grains in storage. Insects' pests cause substantial losses, and their preventive measures increase the value of products. Main storage pests are Beetles, and Moths. After infestation the loss in weight and value of stored grains have been noticed. The losses in storages by insects' pests consist of not only the consumption of the seeds/ grains. The physical damage caused by the infestation of stored grains makes it non-consumable as it also has effect on its quality by the addition of urine and faeces [5]. Commonly reported types of Beetles, and Moths are *Angoumois grain moth*, *Rhyzopertha dominica*, *Tribolium castaneum*, *Khapra beetles* and *Sitophilus oryzae* from the grains storages cause huge loss. The present research work was based on identification, prevalence rate and to search out the condition of storages of grains in Quetta, Pishin, Loralai and Sibi districts of provinces of Baluchistan, Pakistan during 2019 to 2020 (Covid-19 Time period).

The objective of this research is to identify the insect pests and their prevalence rate in different districts of Balochistan, Pakistan.

## Methodology

### Sampling Design

Insect pests of stored grains such as Wheat, Rice, Maize and Barley from four districts of Balochistan, Pakistan were collected from a hot climatic area of district Sibi, Loralai and two from cold climatic districts Quetta and Pishin. Five storages/godowns had been selected in each district. The

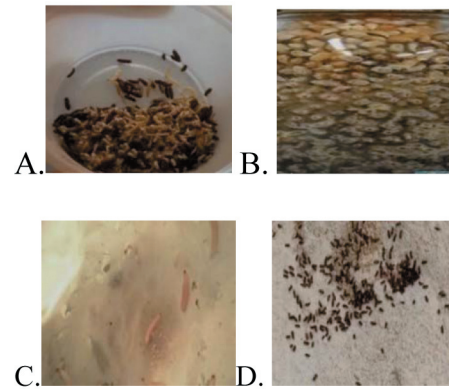


Fig 1. A. *Tribolium* with Wheat. B, C. *Angoumois* with maize D. Weevils with rice

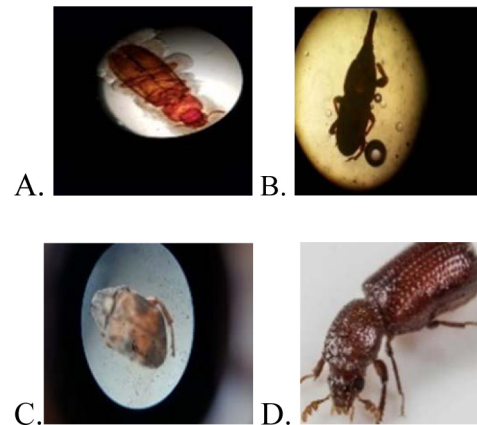


Fig. 2. Microscopic Slides of A. *T. castaneum*; B. *S. oryzae*; C. *T. granarium*; D. *R. dominica*.

collection was done on a monthly basis from 04 sites of each godown. Insect pest samples had been brought to the laboratory in paper bags (size 10×10cm) were properly labeled (locality and date of collection), plastic bags were closed by the help of rubber bands to prevent contamination. These were immediately shifted to lab and cultured of the method given for the confirmation of specific insect pests damage the commonly used cereals of Balochistan [1].

## Experimental designs

### Culturing of Insect Pests

For the collection of insects from the post-harvest stocks, grains were sieved with a 4 mesh/m<sup>2</sup> sieve. Collected and counted on monthly basis. For verification of insect pests from their specific grains, after cleaning grains were disinfested by fumigation in airtight container. For this purpose, ALP 3 tablets /m<sup>2</sup> were used. The bins were closed at least 10 days to confirm the complete mortality of insects [1]. The post-harvest grains were kept overnight at room temperature before adjusting their moisture content to 14 percent by adding tap water as per formula [1]. This was done to acclimatize insects with the environment [6]. Test insect species were produced/released in the jar at three levels i.e., 6, 8 and 10 pairs/500 g grains of initial infestation. One day old

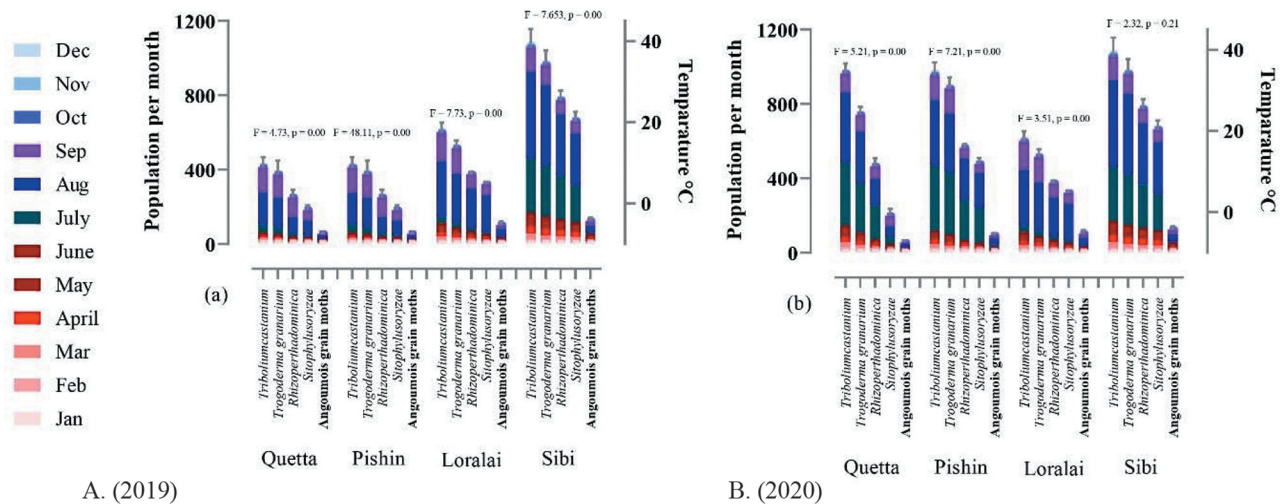


Fig. 3. Showing prevalence of Insect pests in 2019 (A) and 2020 (B) in different divisions of Balochistan.

adult pairs of each specie were released in jars. The mouth of jars was covered with muslin cloth which was kept tight with the help of rubber bands after the release of insects. The experiment was conducted in room conditions (six months) and each treatment contained 500 g grains in the glass jars (15×10 cm). Six sets were used for getting reliable observations. After every month, observation of single set was noticed and discarded this set. One set was used and taken out after noting down its observation after each month. Count and identify species of insects with the help of standard keys which are used for their identification.

## Results

Infestation of Insect pests of stored grains is a serious problem throughout the world. These are not only causes of grain loss in fields but also in storages on the large scale. During this research work 106,350 insect pests were collected in two years on a monthly basis from different 25 godowns of hot and cold climatic area of province of Balochistan from 2019 to 2020 (Table 1-4). Among the collected insect pests' moths (Lepidoptera) and beetles (Coleoptera) were recorded and identified. These samples were identified by using the standard identification keys [1 – 3].

The collected data proved high prevalence rate of insect pests in Balochistan especially in warm climatic regions like Loralai and Sibi in 2020 (Table 6). Many direct and indirect factors and reasons have been found during this research work which gave support to the rapid population of Insect pests of storages. More Insect Pests have been collected from Sibi and Loralai both in 2019 and 2020 but high in 2020 when compared both years with each other. (Table 6, Chart 1 A, B) Sibi: *Tribolium castaneum* were found with 10.28% and increased to 13.54% in 2020. *Trogoderma granarium* from 9.28% to 12.25%, *Rhizopertha dominica* were from 7.18% to 9.83%, *Sitophylus oryzae* from 7.18%

to 8.40% and *Angoumois grain moths* were collected from 1.06% to 1.59% Loralai. *Tribolium castaneum* were found with 7.64% and increased to 7.90% in 2020. *Trogoderma granarium* from 6.55% to 7.16%, *Rhizopertha dominica* were from 4.77% to 5.16%, *Sitophylus oryzae* from 4.08% to 4.21% and *Angoumois grain moths* were collected from 1.30% to 0.85%. Pishin: *Tribolium castaneum* were found with 5.26% and increased to 7.23% in 2020. *Trogoderma granarium* from 4.78% to 6.66%, *Rhizopertha dominica* were from 3.18% to 4.26% *Sitophylus oryzae* from 2.30% to 3.57% and *Angoumois grain moths* were collected from 0.70% to same % in next year 2020 Quetta: *Tribolium castaneum* were found with 5.03% and increased to 7.25% in 2020 *Trogoderma granarium* from 3.80% to 5.56%, *Rhizopertha dominica* were from 2.67% to 3.48%, *Sitophylus oryzae* from 1.75% to 1.49% and *Angoumois grain moths* were collected from 0.51% to 0.41% *Sitophylus oryzae* and *Angoumois grain moths* were found less in 2020 in Quetta as compared to 2019 because little bit changed circumstances in godowns both in 2019 and 2020. Overall prevalence of Insect Pests was found high in Sibi with 34.03 % in 2019 while in 2020 it was 45.62.31%, Loralai with 24.34% to 25.31%, Pishin had 16.23% to 22.44% while in Quetta were from 13.78% in 2019 to 18% in 2020 (Table. 5 & 6) (Chart. 1). On the other hand, when compared collected data on the basis of kind of Godowns, Government godowns with open area stored grains had shown more insect pests than Private godowns (Table 7 & 8) due to better construction/ repairing/ facilities and main reason is individual owner system. Sibi Govt. godowns had shown 11.74% in 2019 while in 2020 it was 16.42%, In open area from 6.95% to 12.30% while in Private godowns had 15.34% in 2019 and increased to 16.89% in 2020. Loralai Govt. godowns had shown 9.37% in 2019 while in 2020 it was 10.53%, In open area from 5.93% to 3.98% while in Private godowns had 9.03% in



Fig. 3. A, B. Govt.godowns in Balochistan. C-G. Stored grains in open area. H, I. Private godowns.

2019 and increased to 9.28% in 2020. Pishin Govt. godowns had shown 7.29% in 2019 while in 2020 it was 10.42%, In open area from 4.72% to 5.65% while in Private godowns had 4.21% in 2019 and increased to 6.63% in 2020. Quetta Govt. godowns had shown 7.55% in 2019 while in 2020 it was 8.49%, In open area from 3.34% to 5.66% while in Private godowns had 2.88% in 2019 and increased to 4.04% in 2020. More temperature speeds up the reproductive rate of insect pests and more progenies had been observed. specially in June, July and August also matched from researchers [7–9]. This increased temperature and humidity absorbed by the surroundings and affected on insect population. 28c to 32c in active form but from 15c to 18c abled to grow with low activity. **Mostly insect pests had been found and collected from March to September while from October to February they were but in little numbers in each godown.** Their survival temperature was noticed from 5 to 41 C for stored grain Insect Pests matched with the research [7,10]

### Condition of Godowns in Baluchistan

Condition of Godowns in Baluchistan. Private and Govt. godowns in Baluchistan varies both in space and quality. Their length is usually 111 ft and width is 49 ft and height is 20 ft, made of mud and bricks. Cracks have been visibled from inside and outside Private godowns are well facilitated and repaired annually due to owned individually, while Govt. godowns (Fig. A, B) are larger in size but usually not repaired and facilitated regularly due to lack of funds.

Many times, management used open areas (Fig. C-G) to keep stored grains and infestation occurs rapidly in sunny and moist days. This external and internal temperature difference and their prevalence had also been matched with research work [11]. Stored grains kept there more than year and not shifted or transported to other areas cause shortages just to get more money.

On the basic level farmers and Godown’s owners should have proper hygienic practices which is the need of healthy stored grains also discussed by Anjaly Paul [12]. During COVID-19 (2019 and especially in 2020) due to reason of insecure condition around, traders and godowns owners started to accumulate stored grains intended to cause shortages and selling at high prices. Along with the increase in problems in transportation stored grains remained in godowns/open area for long time which caused high infestation in stored grains specially in 2020 as compared to 2019. Before storage grains gave better result for preservation when dried properly and changed their layers after some days if humidity was less 10%, it found no or few insect pests but otherwise more than 15% insect pests found with active reproductive rate stacks was placed with suitable space with each other and also from

roof, cracks of walls. This activity also changed the number of insect pests in stacks.

## Statistical Analysis

A One-way ANOVA was performed to determine if there were a difference in Locations and seasons for Insect pests' collection in different districts of Balochistan. Descriptive statistics showed that the Sibi district was abundant for the presence of insect pests (Result of Table 6) A graphical representation clearly showed that the intensity of insect pests was increased in summer (From May to Sept.) while in the winter season (Oct. to April) it was reduced (Chart: 1). According to bar graphs, the mean number of insect pests found in abundance in the Sibi district A bar graph was used to indicate frequent appearance of insect pests in different districts and among all these *Tribolium castanum* was higher and *Angoumois grain moths* were in small quantities estimated marginal means plot showed that the presence of insect pests was greater in the Sibi district among all stations while the Quetta station was least. To perform the statistical analysis, statistical PAST software SPSS version 4 and applied one way ANOVA. P value was considered significant at 0.05.

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### 3<sup>rd</sup> District Loralai

1. Govt. Godowns: G1, G2 = Govt. godowns (Loralai purchase centre; G3 = Plinth (open area);
2. Private Godowns: G4 and G5 = Godowns from Loralai mills

Table 3. Prevalence of Insect Pests in godowns of Loralai district during 2019- 2020

Months	January		February		March		April		May		June		July		August		September		October		November		December	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
<b>Loralai</b>																								
<i>Insect Pests (2019)</i>	35	27	38	33	20	24	47	62	53	29	47	53	73	65	69	51	20	68	53	59	49	73	83	59
1. <i>Tribolium castaneum</i>	6	7	11	4	9	7	17	22	4	9	15	35	30	23	29	12	16	16	23	19	28	19	31	25
2. <i>Trigoderma granarium</i>	3	3	3	7	8	13	16	2	9	16	33	12	16	24	16	17	16	15	12	13	18	21	14	23
3. <i>Rhizopertha dominica</i>	2	9	3	2	8	7	11	4	6	7	13	10	12	15	14	18	13	10	11	9	36	20	7	12
4. <i>Sitophilus oryzae</i>	1	3	2	1	7	9	1	4	7	8	9	14	8	9	14	8	11	11	8	9	12	10	11	9
5. <i>Anagomus granivorus</i>	1	3	1	0	5	4	2	1	2	3	5	7	1	3	3	2	4	8	1	11	23	5	7	4

Months	January		February		March		April		May		June		July		August		September		October		November		December	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
<b>Loralai</b>																								
<i>Insect Pests (2020)</i>	43	64	59	37	59	66	85	83	121	76	98	119	107	130	72	60	102	108	158	78	94	123	109	137
1. <i>Tribolium castaneum</i>	34	10	30	13	17	19	25	34	39	26	28	37	37	42	19	26	32	31	50	18	24	39	36	43
2. <i>Trigoderma granarium</i>	9	14	9	6	14	18	21	24	22	33	27	39	32	30	33	21	23	41	18	20	35	28	37	29
3. <i>Rhizopertha dominica</i>	9	18	9	9	15	18	14	24	14	24	13	19	22	19	27	11	28	23	33	28	23	27	25	38
4. <i>Sitophilus oryzae</i>	9	8	7	6	9	18	11	11	22	9	20	21	20	24	11	18	18	18	24	16	9	12	12	22
5. <i>Anagomus granivorus</i>	2	3	5	2	7	5	6	1	2	3	1	12	7	1	4	6	10	4	8	9	8	13	44	17

### 4<sup>th</sup> District Sibi

1. Govt. Godowns: G1, G2 = Govt. godowns Allabad road; G3 = Plinth form (open area)
2. Private Godowns: G4 and G5 = Godowns from Sibi flour mills on bypass road

Table 4. Prevalence of Insect Pests in godowns of Sibi district during 2019- 2020

Months	January		February		March		April		May		June		July		August		September		October		November		December	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
<b>Sibi</b>																								
<i>Insect Pests (2019)</i>	29	16	54	17	32	39	57	59	9	16	33	33	83	83	104	83	91	94	97	119	139	89	156	83
1. <i>Tribolium castaneum</i>	8	7	38	6	9	10	16	17	5	4	25	39	48	31	47	25	32	46	32	38	28	30	35	39
2. <i>Trigoderma granarium</i>	8	8	13	4	9	8	15	18	4	4	23	19	41	20	38	23	44	46	25	27	32	31	52	30
3. <i>Rhizopertha dominica</i>	6	9	5	6	7	12	17	3	22	25	39	39	31	18	35	38	29	32	39	33	39	25	24	21
4. <i>Sitophilus oryzae</i>	4	6	8	2	8	9	13	5	18	11	33	22	31	19	22	34	20	31	15	10	40	27	20	15
5. <i>Anagomus granivorus</i>	3	6	0	3	6	5	4	0	5	7	2	12	9	6	9	6	9	6	9	6	9	6	10	20

Months	January		February		March		April		May		June		July		August		September		October		November		December	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
<b>Sibi</b>																								
<i>Insect Pests (2020)</i>	42	53	48	51	65	71	89	119	97	113	168	157	362	114	500	108	866	93	98	104	100	134	239	177
1. <i>Tribolium castaneum</i>	35	16	25	18	22	24	32	31	30	33	45	44	51	33	45	23	50	57	22	59	31	37	31	45
2. <i>Trigoderma granarium</i>	12	16	21	23	19	27	28	34	30	38	35	50	43	23	38	41	21	44	27	31	52	27	37	63
3. <i>Rhizopertha dominica</i>	6	12	38	4	19	14	10	26	21	30	33	36	20	38	22	38	22	29	49	26	35	24	35	61
4. <i>Sitophilus oryzae</i>	6	7	13	11	14	12	13	15	17	13	18	23	18	25	30	42	19	31	41	27	31	22	45	19
5. <i>Anagomus granivorus</i>	3	2	4	9	7	2	9	3	3	19	9	33	30	16	10	34	9	8	5	6	10	6	32	17

Table 5. Percentage of Insect Pests in godowns of different divisions of Baluchistan during 2019

Insect Pests	QUETTA	PISHIN	LORALAI	SIBI
<i>Triboliumcastanium</i>	5.03%	5.26%	7.64%	10.28%
<i>Trogoderma granarium</i>	3.80%	4.78%	6.55%	9.28%
<i>Rhizopertha dominica</i>	2.67%	3.18%	4.77%	7.18%
<i>Sitophylus oryzae</i>	1.75%	2.30%	4.08%	7.18%
<i>Angoumois grain moths</i>	0.51%	0.70%	1.30%	1.06%
<b>TOTAL</b>	<b>13.78%</b>	<b>16.23%</b>	<b>24.34%</b>	<b>34.03%</b>

Table 6. Percentage of Insect Pests in godowns of different divisions of Baluchistan during 2020

Insect Pests	QUETTA	PISHIN	LORALAI	SIBI
<i>Triboliumcastanium</i>	7.25%	7.23%	7.90%	13.54%
<i>Trogoderma granarium</i>	5.56%	6.66%	7.16%	12.25%
<i>Rhizopertha dominica</i>	3.48%	4.26%	5.16%	9.83%
<i>Sitophylus oryzae</i>	1.49%	3.57%	4.21%	8.40%
<i>Angoumois grain moths</i>	0.41%	0.70%	0.85%	1.59%
<b>TOTAL</b>	<b>18%</b>	<b>22.44%</b>	<b>25.31%</b>	<b>45.62%</b>

Table 7. Overall Percentage of Prevalence of Insect Pests in Govt. Godowns/Open area/ Private Godowns in different districts of Baluchistan during 2019.

INSECT PESTS	QUETTA	PISHIN	LORALAI	SIBI
Govt. Godowns	7.55%	7.29%	9.37%	11.74%
Open Area (Plinth)	3.34%	4.72%	5.93%	6.95%
Private Godowns	2.88%	4.21%	9.03%	15.34%
<b>TOTAL</b>	<b>13.85%</b>	<b>16.23%</b>	<b>24.34%</b>	<b>34.03%</b>

Table 8. Overall Percentage of Prevalence of Insect Pests in Govt. Godowns/Open area/ Private Godowns in different districts of Baluchistan during 2020.

INSECT PESTS	QUETTA	PISHIN	LORALAI	SIBI
Govt. Godowns	8.49%	10.42%	10.53%	16.42%
Plinth (Open Area)	5.66%	5.65%	3.98%	12.30%
Private Godowns	4.04%	6.36%	9.28%	16.89%
<b>TOTAL</b>	<b>18.20%</b>	<b>22.44%</b>	<b>25.31%</b>	<b>45.62%</b>

Table 9. % loss of stored grains sack of 100 kg each due to insect pests in different godowns of different districts of Balochistan in 2019

Districts	Godown-1	Godown-2	Godown-3	Godown-4	Godown-5	Total loss %
1. Quetta	5/100	10/100	4/100	11/100	7/100	7.4%
2. Pishin	14/100	12/100	9/100	10/100	7/100	10.4%
3. Loralai	24/100	23/100	10/100	12/100	11/100	16%
4. Sibi	11/100	21/100	34/100	9/100	22/100	19.4%
						+ 53.2 / 4 = <b>13.3%</b>

Table 10. % loss of stored grains sack of 100 kg due to insect pests in different godowns of different districts of Balochistan in 2020

Districts	Godown-1	Godown-2	Godown-3	Godown-4	Godown-5	Total loss %
1. Quetta	11/100	13/100	9/100	20/100	16/100	13.8%
2. Pishin	21/100	9/100	30/100	17/100	18/100	19%
3. Loralai	30/100	34/100	28/100	24/100	29/100	29%
4. Sibi	29/100	37/100	37/100	31/100	29/100	32.6%
						+ 94.4 / 4 = <b>23.6%</b>

Table 11. Identification of Potential constraints in different districts of Balochistan, Pakistan to get rid the loss of stored grains

	Constraints	Quetta	Pishin	Loralai	Sibi
1	Appropriate legislation in PASSCO and private agencies follow healthy grains	++	+-	+-	+-
2	Scientifically based strategies	++	+-	+-	++
3	Adequate grains handling facilities	+-	+-	+-	+-
4	Effective handling, Marketing and Storing of grains programs/workshops and seminars	++	+-	+-	+-
5	Literacy rate	++	+-	+-	+-
6	Social status of farmers, Godown owners and traders	+-	-	-	-