Tr. J. of Zoology
22 (1998) 167-174


**Research Article**

# Productivity enhancement of rice crop yield through prevention of losses due to wild boars in Pakistan

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Received: 10.12.1996

**Abstract:** The wild boar control trials were conducted in rice fields in the districts of Sheikhupura, Sialkot, Faisalabad and Gujrat, covering an overall area of 3000 hectares. Zinc phosphide encapsulated bait was used resulting in 80-100% reductions in wild boar activity. In addition, the impact of the boar control work on the crop productivity was evaluated by interviewing 391 farmers selected randomly from the trial areas. The average farm size of the sampled farmers was 426.30 hectares. The average yield loss due to wild boars was estimated at 22.75%. By applying newly developed zinc phosphide capsular technology, 502.17 mt. of rice was saved.

Key Words: (*Sus scrofa cristatus*, zinc phosphide, yield increase, Punjab).

### Pakistan'da Yaban Domuzu Zararının Önlenmesi Yoluyla Çeltik Ürününde Artış Sağlanması

**Özet:** Bu makalede Pakistan'ın dört ayrı bölgesinde pirinç tarımı yapılan toplam 3000 nektarlık sahada zararı yaygın olan Yaban domuzu (*Sus scrofa cristatus*)'na karşı kullanılan ve etken madde olarak çinko fosfit içeren zehirli yemlerin, domuz zararının kontröl altına alınması bakımından ne derece etkili olduğu ve ayrıca zararın azaltılmasıyla pirinç ürün verimliliğinde sağlanan artışın ne kadar olduğu araştırılmıştır.

Çalışma sahasına tesadüfi olarak dağıtılan deneme alanlarına bırakılan ve domuz tarafından tüketilen zehirli yemlerin kullanım öncesi ve sonrası kaydedilen sayıları veri olarak kullanılmıştır. Ayrıca, ortalama genişlikleri 426.3 hektar olan bu 391 çiftliğin sahibiyle yapılan mülakata dayanarak, domuz populasyonundaki azalma tahmin edilmeye çalışılmış ve bu azalma sayesinde kurtarılan ürün miktarı esas alınarak kontrol çalışmalarının ekonomik analizi yapılmıştır. Buna göre, domuzun sebebiyet verdiği %22.75'lik ürün kaybına mukabil geliştirilen zehirli yem tekniğiyle domuz faaliyeti %88-100 oranında azaltılabilmiş ve böylece 502.17 mt ürün kurtarılmıştır.

Anahtar Sözcükler: *Sus scrofa cristatus*, çinko fosfit, verim artışı, Pencap

## Introduction

Wild boars (*Sus scrofa cristatus),* are considered a major pest in Pakistan because of their causing reductions in the productivity of various agricultural crops (1, 2, 3, 4). They are especially significant pests in the cultivation of sugarcane, potatoes, maize (especially during the cob formation stage) and wheat during the sowing and maturity stages (5, 6). No loss of rice crops due to wild boars has ever been documented. However, according to Roberts (5) and Anon. (7) wild boars damage rice crops during the milky stage.

From the farmer's point of view, it is nearly impossible to deal with this kind of vertebrate pest. (8). The fear of being attacked by the boars is also one of the reasons why farmers do not take much action to control them.

Of all the control methods (shooting, trapping, use of exotic diseases, electric fencing, earthwalls, construction of walls around fileds, hunting, netting and explosives) used against wild boars, poison baiting is the only measure which is cheap, easy, economical and effective. Even the chemical control measures tried in the past have proved ineffective mainly because i) wild boars have acute senses of smell and taste (5) and hence are repelled by the acute poisons ii) slow-acting poisons require several days before being effective against the pest and hence farmers are discouraged from using them. To overcome these problems the scientists of the Vertebrate Pest Control Laboratory, Karachi have developed a new technique under the Productivity Enhancement Programme (PEP) sponsored by the Pakistan Agricultural Research Council, Islamabad. This paper presents the results of this innovative poison baiting technique against wild boars and their impact on the productivity of rice crops.

## Materials and Methods

### Study area

Wild boar control trials were conducted from September to October, 1994 in rice crop fileds during the milky/grain hardening stage) in four important rice-producing districts of the Punjab, Pakistan viz., Sheikhupura (31°42'N 73°59'E), Sialkot (32°28'N 74°32'E), Faisalabad (31°25'N 73°05'E) and Gujrat (32°35'N 74°05'E) (Fig. 1).

Four tehsils (sub-districts) viz. sheikhupura, Sialkot, Faisalabad and Gujrat (one from each district) were selected. From each of these tehsils 3 villages were selected. As these villages were located near wild areas of tall grasses (*Saccharum* spp.), forest plantations (*Acacia arabica, Prosopis juliflora* and *Dalbergia sisso*) and/or canalside plantations (*Prosopis juliflora, Dalbergia sisso* and *Acacia arabica*) providing excellent perennial shelter for the boars; agricultural crops including rice were highly susceptible to their invasion.

### Capsular bait and bait formulation

Bait was made from wheat flour mixed into a dough. Small balls, each with a weight of about 100g, were made from this dough prior to their use in the fields. One capsule containing zinc phosphide (0.7 g) was embedded into each dough ball before placing it in the field. Zinc phosphide was selected as the poison because of its lower toxicity potential to nontarget predators (9). These capsules were then paraffinized with low melting point wax following the process described by Marsh (10) to i) mask the strong garlic-like smell and taste of the boar (5) ii) protect the zinc phosphide and capsules from moisture etc. iii) delay the release of the poison in the gastrointentinal tract to permit its lethal accumulation and to reduce the natural emetic action the wild boars'safeguard to zinc phosphide.

### Method of Baiting

Pretreatment baiting with plain dough balls was carried out for 3 nights to attract the maximum number of boars before treatment baiting. Treatment baiting with zinc phosphide capsules started on the 4th night and continued for 2 nights. Posttreatment baiting, also with the plain dough balls, was carried out only for 1 night, two nights after treatment baiting i.e. on the 8th night. Posttreatment activity index was collected on the 9th day. The number of balls put down during each of the two nights of treatment baiting was similar to those eaten during the last night of pretreatment baiting.

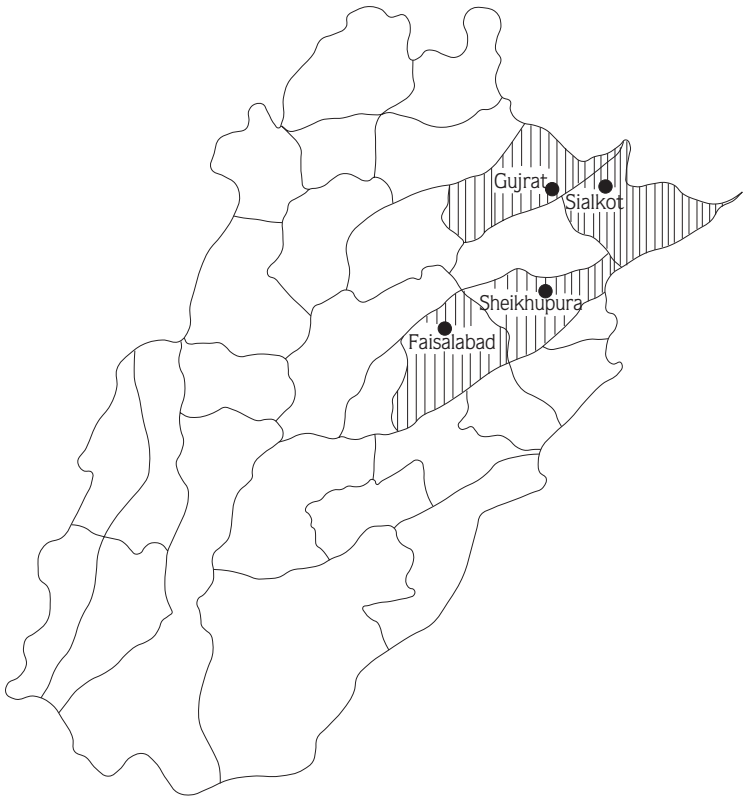


Figure 1. Wid boar control trial area in the Punjab, Pakistan.

The dough balls were placed about half an hour before sunset in sets of 3-4 where recent wild boar activity was evident.

Daily consumption of the bait was noted early in the morning and replenished the next evening. The bait was retrieved from the fileds during the day for rebaiting in the afternooon and to prevent other diurnal nontarget species from feeding on it. This also prevents birds from being exposed to the balls containing the poison capsules.

### Determination of the success of the control trials

The successs of the capsular baiting programme was ascertained on the basis of a) counts of wild boar foot prints b) the activity index of the boars c) interviews with the farmers.

#### a. *Footprint counts of the wild boars*

The presence and number of footprints of wild boars and other nontarget animals (if any) visiting the dough balls daily during pretreatment, treatment and posttreatment baiting was noted.

#### b. *Activity index*

Following the process described by Shafi and Khokhar (6) the percentage of the boar activity index calculated by the following formula was used as an index of their population density.

$$\frac{\text{No. of dough balls eaten on the last day of pretreatment} - \text{No. of dough balls eaten during the posttreatment}}{\text{No. of dough balls eaten on the last day of pretreatment}} \times 100$$

#### c. *Interviews with the farmers*

Pretreatment and posttreatment surveys were carried out before and after the rice crop harvest, respectively.

Based on these surveys reductions in losses and increases in yields of rice were evaluated by interviewing the farmers following the process decsribed by Krebs (11).

### Collection of yield data

Inorder to collect rice yield data, farmers were interviewed before and after the wild boar control trials. From each village 10% of the total farmers (if found avaliable in the fileds at the time of interview) were selected randomly for interview.

### Estimation of cost benefit ratio

The cost benefil ratio (CBR) was estimated on the basis of: the cost of increased rice yield as ratio of cost of inputs including bait material, poison, labour etc.

### Analysis of the data

The data were statistically analysed using standard deviation, standard error, student t-test, coefficient of variations, etc. following the processes described by Lyman, (12).

## Results and Discussion

### A. Evaluation of capsular baiting

The results of capsular baiting in rice crop fields are shown in Table 1,

The consumption of the balls on the second and third nights of pretreatment baiting was almost constant at most of the sites. This suggested maximum assemblage of the boars at the baiting ponits.

Wild boar activity fell sharply by 90 to 100% at all the baiting sites except in Langowal in the Sheikhupura district where it was 80.4%. the wild boar behaviour at these baiting stations was stated by the farmers to have been disturbed by boar-hunting parties.

The capsular baiting technique has already been used in agricultural areas of the Punjab, Pakistan killing innumerable wild boars (13). During the present studies only nine dead bodies of wild boars could be found in the open fields following capsular poison baiting. However, foul smells from the wild boar habitation areas (forests, areas of tall grasses etc.) were a common observation. The foul smells may also be of nontarget dead animals but comparison of the shape and number of footprints of wild boars noted during the pretreatment and treatment periods with those of the posttreatment period dispelled this confusion and therefore suggested a marked reduction in the visits of the boars only (Fig. 2). Although there is no accurate measurement of the number of boars visiting the dough balls, Figure 2 does suggest a general increase in activity before and a sharp reduction after treatment. In addition, no footprints of the nontarget animals near the baiting points during the baiting programme were noted, which therefore suggests that the foul smell was emanating from the dead bodies of wild boars. Also, because of the fact that zinc phosphide is the slowest acting acute poison (14, 15), therefore the pests have ample opportunity to go back to their hideouts (5). Moreover, the paraffinization of the poison capsules most probably delays the release of the poison within the

Table 1. Results of the poison baiting trials against wild boars (*Sus scrofa cristatus*) in rice fileds in areas of the Punjab.

| Site | Pretreatment baiting | | | * Treatment baiting | | ** Postreatment baiting | Reduction in activity % |
|---|---|---|---|---|---|---|---|
| | Day-1 | Day-2 | Day-3 | Day-4 | Day-5 | | |
| Sheikhupura District | | | | | | | |
| Langowal | 55/50 | 76/42 | 100/46 | 46/31 | 46/1 | 9 | 80.4 |
| Gatiawala | 105/95 | 131/130 | 151/145 | 145/101 | 145/5 | 4 | 97.2 |
| Sultanpura | 97/75 | 110/70 | 123/101 | 101/59 | 101/8 | 8 | 92.0 |
| Sialkot District | | | | | | | |
| Dally Wali | 125/100 | 408/265 | 391/300 | 300/263 | 300/19 | 6 | 98.0 |
| Ghazipur | 85/80 | 205/190 | 349/240 | 240/201 | 240/7 | 0 | 100.0 |
| Gurukhair | 101/100 | 400/300 | 450/345 | 345/250 | 345/19 | 8 | 97.7 |
| Faisalabad District | | | | | | | |
| RB-121 | 51/25 | 53/28 | 58/31 | 31/11 | 31/2 | 2 | 92.5 |
| Sahuwala | 149/80 | 200/83 | 206/94 | 206/131 | 206/7 | 7 | 92.6 |
| (RB-132) | | | | | | | |
| Motaili | 139/120 | 201/143 | 249/181 | 181/93 | 181/0 | 0 | 100.0 |
| (RB-143) | | | | | | | |
| Gujrat District | | | | | | | |
| Hill Minhasa | 50/50 | 190/120 | 189/138 | 138/91 | 138/3 | 7 | 94.9 |
| Tool Chapala | 195/152 | 209/140 | 208/150 | 150/115 | 150/11 | 5 | 96.7 |
| Simbly Rai | 153/105 | 169/151 | 191/159 | 159/75 | 159/3 | 11 | 93.1 |

* Numerators indicate No. of dough balis placed each night while denominators indicate No. of dough balls eaten by the boars.

** No. of dough balls eaten by the boars.

N.B. No. of dough placed have not been shown in the postreatment baiting data.

gastrointestinal tract of the boars leading to slow, adverse symptoms which enable the affected boars to return to their hideouts.

### B. Impact of the baiting on rice yield

#### Average farm size

The overall farm size of the 391 sample farmers was 3.71 hectares. The average farm size were 1.25, 5.05, 1.48 and 7.07 hectares in the Sheikhupura, Sialkot, Faisalabad and Gujrat districts, respectively (Table 2).

#### Losses due to wild boars

The losses of rice due to wild boars in four districts of the Punjab are shown in Table 3. The average loss was 22.75%. The losses were 13.25%, 26.11%, 26.32% and 25.33% in the Sheikhupura, Sialkot, Faisalabad and Gujrat districts, respectively. Sheikhupura registered a smaller loss compared with the other three districts. The coefficients of variations for the distribution of losses ranged from 33.51% to 75.72%. The C. Vs for the loss distribution were 33.51% and 37.28% for Sialkot and Sheikhupura, respectively and 49.24% and 75.72% for Faisalabad and Gujrat, respectively. This suggested that the distributions of loss for Sialkot and Sheikhupura were more consistent. The higher C. Vs of loss distribution for Faisalabad and Gujrat implied that there was more nonuniformity in the loss in these two districts.

#### Rice losses by district

Rice losses due to wild boars between Faisalabad and Gujrat, Faisalabad and Sialkot, and Gujrat and Sialkot showed no significant difference ($P>0.05$) Table 4). This lack of significance in losses between Gujrat and Sialkot was most probably due to the fact that the survey areas in these districts lie very close to each other, taking into consideration the sources of boar invasion. However, the rice loss in Faisalabad was significantly higher than that in

Table 2. Sampled cultivated area under rice in the Punjab (data based on the interviews with the farmers)

| District | No. of farmers inter-viewed | Cultivated area per farmer (hectares) | Total cultivated area (hectares) |
|---|---|---|---|
| Sheikhupura | 75 | 1.25 | 93.75 |
| Sialkot | 145 | 5.05 | 732.25 |
| Faisalabad | 59 | 1.48 | 87.32 |
| Gujrat | 112 | 7.07 | 791.84 |
| Total: | 391 | 3.71 | 426.30 |

Sheikhupura ($t=5.97$, $P<0.05$, $df=120.91$). Similarly, the losses in Gujrat and Sialkot were significantly higher than that in Sheikhupura ($t=5.07$, $P<0.05$, $df=120.91$) and ($t=9.96$, $P<0.05$, $df=128.06$), respectively. As these districts lie far from each other, there was a high chance of singificantly different losses being inflicted.

### Rice yield estimates

Rice yield estimates before and after the use of capsular technology are shown in Table 5. The overall increase in rice in the four district of the Punjab was 502.17 tonnes (33.47%).

The increase in rice varied from 14.14 tonnes (15.27%) in the Sheikhupura district to 234.05 tonnes (33.92%) in the Gujrat district. The increases in the Faisalabad and Sialkot districts were recorded as 28.50 tonnes (35.84%) and 225.48 tonnes (35.33%), respectively.

### Cost benefit ratio

The cost benefit ratio (CBR) is given in Table 6. The CBR for rice without labour was 1:873 and with labour was 1:140. According to Khan (16) the cost benefit ratio (CBR) was estimated at 1:36 (without labour) in sugarcane crops when using zinc phosphide rice bait against rodents. Similarly Anon (17) calculated a cost benefit ratio of 1:366 when increasing the yield of groundnut crop using zinc phosphide, coumatetralyl and floco umafen.

However, the CBR in standing rice crops was calculated at 1:873, much higher than that of sugarcane and groundnut. Comparatively higher cost effectiveness in this study can be explained by the fact that wild boars, being large and bulky pests, cause considerably more damage than rats. Moreover, they destroy large quantities of rice crops by eating and trampling which result in the total loss of the crop to the farmer. This is because the growth of the trampled crop is neither regenerated nor is consumed by the livestock as fodder due to a peculiar smell emitted by these plants (farmers, pers. comm.). In addition, the high rate of return is attributable to the low cost of the poison bait material.

Table 3. Average yield loss of rice crop due to wild boars in the Punjab.

| District | No. of farmers | Average yield loss % | SD | SE | CV % |
|---|---|---|---|---|---|
| Sheikhupura | 75 | 13.25 | 4.94 | 0.57 | 37.28 |
| Sialkot | 145 | 26.11 | 8.75 | 0.72 | 33.51 |
| Fasilabad | 59 | 26.32 | 12.96 | 1.68 | 49.24 |
| Gujrat | 112 | 25.33 | 19.18 | 1.80 | 75.72 |
| Total: | 391 | 22.75 | 11.46 | 1.20 | 50.37 |

Table 4. Comparison of rice losses due to boars between different districts of the Punjab.

| Name of district | Average yield loss (%) | tc | df | P |
|---|---|---|---|---|
| Sialkot | 26.11 | | | |
| | | 9.96 | 128.06 | P<0.05 |
| Sheikhupura | 13.25 | | | |
| Faisalabad | 26.32 | | | |
| | | 5.97 | 120.91 | P<0.05 |
| Sheikhupura | 13.25 | | | |
| Gujrat | 25.33 | | | |
| | | 5.07 | 120.91 | P<0.05 |
| Sheikhupura | 13.25 | | | |
| Faisalabad | 26.32 | | | |
| | | 0.09 | 14.59 | P>0.05 |
| Sialkot | 26.11 | | | |
| Gujrat | 25.33 | | | |
| | | 0.34 | 14.59 | P>0.05 |
| Sialkot | 26.11 | | | |
| Faisalabad | 26.32 | | | |
| | | 0.28 | 159.34 | P>0.05 |
| Gujrat | 25.33 | | | |

Table 5. Increase in yield of rice due to application of capsular technology against wild boars in the Punjab.

| Districts | Pretreatment yield (tonnes) | Posttreatment yield (tonnes) | Yield increase (tonnes) | Yield increase (%) |
|---|---|---|---|---|
| Sheikhupura | 92.58 | 106.72 | 14.14 | 15.27 |
| Sialkot | 638.04 | 863.52 | 225.48 | 35.33 |
| Faisalabad | 79.52 | 108.02 | 28.50 | 35.84 |
| Gujrat | 689.97 | 924.02 | 234.05 | 33.92 |
| Total | 1500.11 | 2002.28 | 502.17 | 33.47 |

Table 6. Cost benefit ratio regarding wild boar control trials in rice crop fields in the Punjab, Pakistan.

| Parameter | No. | Wt/unit (gms) | Total | Cost/ wt (kg) (Rs.) | (Rs.) | Total cost * USD |
|---|---|---|---|---|---|---|
| INPUTS | | | | | | |
| 1. Wheat dough balls | 10406 | 100 | 1040.6 | 5.00 | 5203.00 | 130.07 |
| 2. Zinc phosphide capsules | 1506 | - | - | 1.00 | 1506.00** | 37.65 |
| 3. Labour | 875 | - | - | 40.00 | 35000.00 | 875.00 |
| Total | | | | | 41709.00 | 1042.72 |
| OUTPUTS | | | | | | |
| 1. Rice (saved) | - | - | 502170 | 11.67 | 5860323.90 | 146508.09 |

* Exchange rate 1USD=40.00 Rs.

** Includes the cost of empty capsules, zinc phosphide and wax.

Cost benefit ratio (CBR)=Output ÷ Input

With labour 1:140

Without labour 1:873

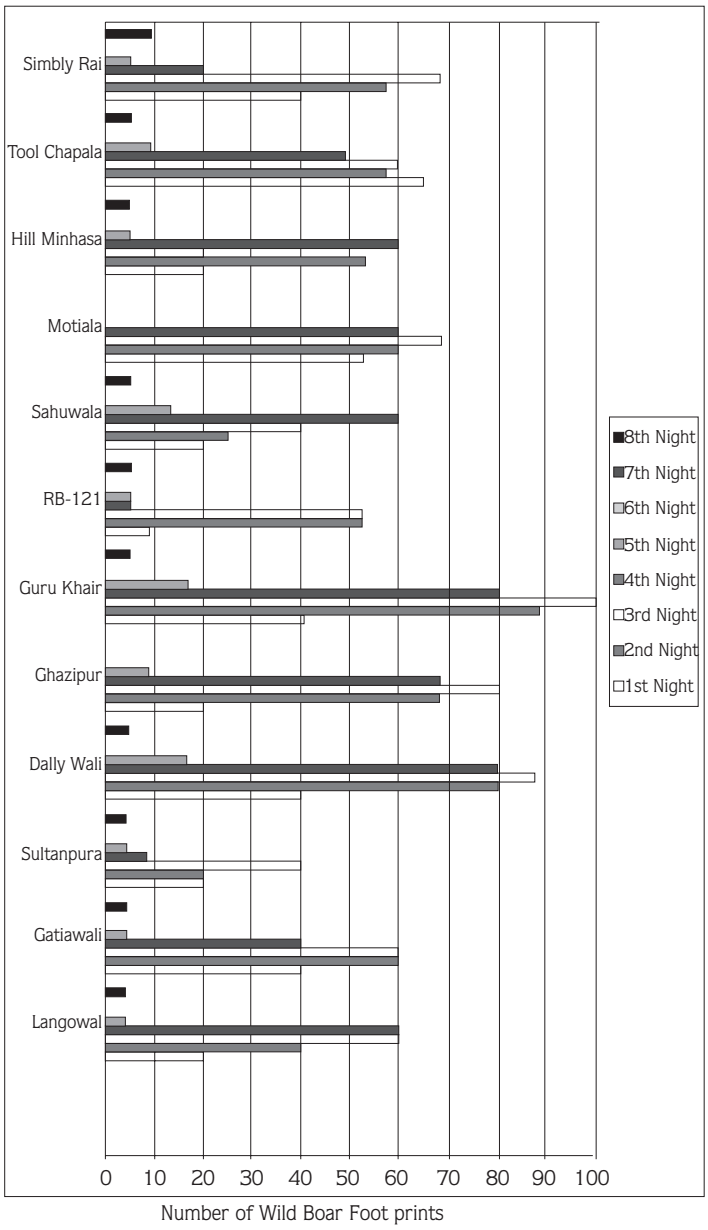


Figure 2. Wild boar activity index based on footprint counts during wheat flour dough ball baiting at 12 villages in the Punjab, Pakistan.

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