Indigenous plant protection practices in dry land agricultural agro ecosystems: Rationality of farmers’ knowledge system

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ABSTRACT
In recent past, the farmers’ knowledge has received increased attention. Looking its importance a study was carried out, six randomly selected villages from two blocks, one from each of Bhiwani and Mahendergarh districts of Haryana state. To explore indigenous technological knowledge (ITKs) farmers with 10 years of experience were selected randomly from each village. Thus, making a total of 180 farmers from six villages. For testing rationality of each explored ITK, 40 agricultural scientists were selected. Data pertaining to study were taken by using personal interview method with open-ended and objective types of questions. Results indicated that 37 of ITKs were explored from farmers which are used against different insect pest management of various crops. Twenty four ITKs were found to be rational as perceived by farmers. Whereas 13 of ITKs were observed to be irrational by the farmers. Same numbers of ITKs were perceived as rational and irrational by agricultural scientists. It could be inferred that there was very less gap in weighting the rationality of explored ITKs by farmers and agricultural scientists both.

Key words: Dry land agro ecosystem, Farmers, Indigenous technological knowledge (ITKs), Plant protection, Rationality.

INTRODUCTION
One of the major input for agriculture is use of various pesticides, like insecticides, weedicides, fungicides, rodenticides etc. As the cropping pattern is becoming more intensive use of these pesticides is also increasing. The global agrochemical market (including herbicides, insecticides, plant growth regulators, rodenticides and molluscicides, but excluding fertilizers) has increased up to US$ 30.2 billion in 1997. Sales of herbicides accounted for 48 per cent of the market, insecticides for 27 per cent, and fungicides for 20 percent. In 1996, the top 20 agrochemical discovery companies controlled 91 percent of the total market. In 1997, sales of crop protection products by the top ten companies alone were 84 per cent of the global market (Abraham et al., 1975). Consumption of insecticide in agriculture has been increased more than 100% from 1971 to 1994-95. For instance, insecticide consumption in India, which was to the tune of 22013 tonnes has increased to 51755 tonnes by 1994-95 (www.indiastat.com). Consumption of all of these pesticides in same duration has increased more than two times, that is from 24305 tonnes to 61357 tonnes. But in recent past, change has been observed in trends of pesticides consumption. As a consequence of adoption of bio intensive Integrated Pest Management Programme in various crops the consumption of chemical pesticide (Tech. Grade) has come down from 66.36 thousand MT during 1994-95 to 43.59 thousand MT during 2001-02 with a reduction of 27.69% (Thirty Seventh Report of Standing Committee on Petroleum and Chemicals, 2002). Consumption pattern of pesticides in India is also very different from world. In India insecticide account for 76% of the total domestic market while herbicides and fungicides have a significantly higher share in the global market. There are wide ranges of regional variations in pesticide consumption in the country.

Farmers in developing countries have quite a sophisticated knowledge of agriculture and natural resources. This knowledge is based on many generations of insights gained through their close interaction with the natural and physical micro-environment (Amusan and Warren, 1999). Variations in environmental circumstances from year to year mean that farming system must be dynamic, if only to ensure sustainability. In an effort to meet various needs, rural communities make use of curiosity experiments, problem-solving experiments, and adaptation experiments (Laired and Kate, 1998). Once validated, the results are added to the body of ancient wisdom. Indigenous knowledge systems (IKS) have a great deal to offer in terms of genetic resources, food and fuel, crop and animal management (Pamela, 1994). Identifying, documenting and incorporating IKS into agricultural extension organizations are essential in order to achieve sustainable agricultural development (Rajasekaran, et al., 1993). Hence, there is enormous interest and growing need to collect, preserve and adopt indigenous agricultural practices (IAP) so as to reduce dependence of farmers on...
external inputs and cost of cultivation practices. Keeping these in view, the present study was formulated to identify and analyze the ITK on plant protection practices in dry land agriculture, with the following specific objectives: identifying the indigenous plant protection practices (IPP) and to find out the degree of scientific rationality of the indigenous plant protection practices.

MATERIALS AND METHODS

The study was conducted in Haryana state of India. Two districts, Bhiwani and Mahendergarh were selected purposively. One block from each district was selected (Siwani and Kanina) randomly. Total six villages namely Jhumpa, Siwani, Barua from block Siwani and villages Kanina, Kareera and Lukhi from block Kanina have been selected randomly (Fig. 1). District Bhiwani is situated between 28.19° & 29.05° north latitude and 75.26° and 76.28° east longitude. Mahendergarh district lies between north latitude 27°47’ to 28°26’ and east longitude 75°56’ to 76°51’. A list of farmers having experience of farming of 10 years was prepared with the help of Village Extension Workers (VEW). From each village, 30 farmers were selected, making a sample of 180 respondents. To take observations on rationality of practices, 40 scientists working at KVKs Bhiwani (4) and Mahendergarh (4), Department of Agronomy (10), Entomology (12) and Plant Pathology (10), Chaudhry Charan Singh Haryana Agricultural University, Hisar were selected purposively.

The data pertaining to study have been collected in two phases. In the first phase, an in-depth discussion was held with some informal key questions to identify the IPP. Also the IPP identified by the researchers were taken up from literature and discussed with the dry land farmers through unstructured depth interviews. An explanation was sought on the IPP screened out from the past researches. In the second phase of data collection, the degree of prevalence of the components of IPP with the farmers as well as the logic for the same was ascertained through a well structured interview schedule. First, the concerned scientists were approached to judge the rationality of inventory on the IPP under following components: (i) to propose the scientific recommendation against each of the IPP, (ii) to know the agreement level of the scientists on five point continuum and (iii) to know whether the IPP should be discontinued or continued. Later on, the sampled farmers were contacted.

Fig 1: Localization of study areas.
to judge the rationality of the IPPP. The rationality of IPPP was measured on five point continuum viz. strongly agree, agree, undecided, disagree and strongly disagree and a score of 5, 4, 3, 2 and 1 were given for “strongly agree”, “agree”, “undecided”, “disagree” and “strongly disagree” respectively. The identified IPPP were categorized into rational and irrational on the bases of mean score. Those practices which were having mean score of equal to mean of possible score and above were categorized as rational and those below the mean of possible score were categorized as irrational. From mean score of both farmers and scientists standard deviation of both is calculated. Z value is calculated using the formula.

### RESULTS AND DISCUSSION

#### Personal attributes of farmers:
The study indicated that majority of the respondents were of old age (67.78%), had primary to metric education (39.45 to 33.33%), with low to medium levels in mass media exposure (59.44 to 30.56%), extension agency contact (35 to 38.89%), innovativeness (48.33%), fatalism (45.00%), rational orientation (62.78%) and scientific orientation (53.33%) whereas majority of them having low social participation (93.33%), medium risk orientation (65.56%) and cosmopoliteness (76.11%), medium to high level of socio-economic status (56.67 to 35.00%), their farming experience was almost equally distributed among all the three categories. The main crops grown by them were wheat, bajra, gram, mustard, cotton and sorghum.

| Independent variables | Mean score | Category | Percentage |
|-----------------------|------------|----------|------------|
| Age                   | 51.89      | Young(<35) | ---        |
|                       |            | Middle(35-45) | 32.22     |
|                       |            | Old(>45) | 67.78      |
| Education             | 3.11       | Illiterate | 07.22      |
|                       |            | Upto Primary | 39.45     |
|                       |            | Upto matric | 33.33     |
|                       |            | Above matric | 20.00    |
| Social participation  | 0.07       | Low       | 93.33      |
|                       |            | Medium    | 06.67      |
|                       |            | High      | ---        |
| Mass media exposure   | 1.47       | Low(<3) | 59.44      |
|                       |            | Medium(3-6) | 30.56     |
|                       |            | High(>6) | 10.00      |
| Extension agency contact | 2.49     | Low(<2) | 35.44      |
|                       |            | Medium(2-3) | 38.89     |
|                       |            | High(>3) | 26.11      |
| Socio-economic status | 13.51      | Low(<12) | 08.33      |
|                       |            | Medium (12-14) | 56.67 |
|                       |            | High(>14) | 35.00      |
| Innovativeness        | 1.69       | Low (Score1) | 48.33 |
|                       |            | Medium(Score2) | 32.78 |
|                       |            | High (Score3) | 18.33 |
| Risk orientation      | 18.21      | Low(<16) | 18.33      |
|                       |            | Medium (16-21) | 65.56 |
|                       |            | High(>21) | 16.11      |
| Scientific orientation| 17.44      | Low(<16) | 29.44      |
|                       |            | Medium (16-21) | 53.33 |
|                       |            | High(>21) | 17.22      |
| Fatalism              | 5.03       | Low (<5) | 41.67      |
|                       |            | Medium (5-7) | 45.00    |
|                       |            | High(>7) | 13.33      |
| Rational orientation  | 1.63       | Low (Score 1) | 37.22 |
|                       |            | Medium (Score2) | 62.78 |
|                       |            | High (Score 3) | ---     |
| Cosmopoliteness       | 5.57       | Low (<5) | 16.67      |
|                       |            | Medium (5-7) | 76.11    |
|                       |            | High(>7) | 07.22      |
|                       |            | Low (<27) | 33.89     |
|                       |            | Medium (27-44) | 37.78 |
|                       |            | High(>44) | 28.33      |
| Farming experience    | 34.22      | Low (<27) | 33.89     |
|                       |            | Medium (27-44) | 37.78   |
|                       |            | High(>44) | 28.33      |
Rationality in disease management practices: It is obvious from Table 1 that for the ITK used in disease management there was difference on the opinion of farmers and scientists with regards to rationality of soaking of pearl millet seeds in salt solution to control the ergot disease. While for the practice neem (Azadirachta indica) oil as sprayed to control powdery mildew in black gram crop, the opinion on rationality was same.

Rationality in integrated pest management: The data presented in Table 1 for rationality regarding IPPP indicate that for eight ITKs namely small trenches are dug around the field and in the field at various places to control hairy caterpillar, deep summer ploughing to control various insects, fixing up the bird perches or broadcast the bajra seeds in grain field, using neem oil to control whiteflies and aphids, disposing crop residues immediately after the harvest to reduce the pest and disease attack in next crop, burning of crop residues and other debris in the night after the first rain of the monsoon, dusting of ash at germination stage to control the house cricket and locust in mustard field, the opinion of farmers and scientists was same. Both of them perceived these plant protection practices as rational. It could be found that for the ITKs fumigating the moong crop with dhoop, offering hairs and one or two dead scorpion for heavy flowering; neem oil is used to control aphids/thrips in moong and mustard, powder of neem fruits to control aphids, hoppers and white flies, growing cowpea as inter crop to control leaf miner in kharif season; spraying extract from tobacco (Nicitiana tabacum) leaves to repel the insect; about 600 gm of tobacco is soaked in water for 2-3 days to develop a solution, filter and spray to control white flies in moong, using garlic (Allium sativum) extract and or neem and aak (Calotropis gigantean) or dhtura (Datura alba) extract for seed treatment to control various disease and termite attack, spraying neem seed kernel extract twice to control pod borers; spraying extract of neem leaf to repel moth, hopper and to kill larvae of many insects, scientists and farmers both were having common opinion, both have perceived irrational. While, for the ITK preparing the pokoras and gulgulas with the mustard oil in the field to reduce the attack of disease, was perceived rational by the farmers and irrational by scientists. For practice neem leaf extract to control mustard sawfly, the perception was reversed.

Rationality status of practices in stored pest: The data presented in Table 1 show that, ITKs such as storing black gram by mixing them with sand; before storage drying seeds of pearl millet properly in sun; storing moong by mixing them with ash; spreading neem leaves at floor of the storage bin and on top of the grains to protect them from pest; regular white washing the storage structure to reduce insect and pest infestation; disinfecting storage structure with smoke of dung cake and neem leaves before storing the grains were perceived to be rational. The practice of putting tar coal sheets in between walls of storage structure and under its floor to protect the grains from moisture, were perceived to be irrational by both the categories of respondents. While, opinion of both the group on the practice of using match boxes at some distance in stored grains to protect them from insects, was different. Farmers have perceived it as rational, whereas scientist opinioned it as irrational.

Rationality on birds: It is obvious from the data presented in Table 1 that, all the ITKs practices related to birds were observed rational by both farmers and scientists.

Despite the traditional feeling attitude of farmers about this own local practices, we could observe that majority of plant protection practices are rated as rational by the scientists.

Soaking of pearl millet seeds in salt solution to control the ergot disease was perceived irrational by farmers while scientists perceived it rational. Further, analysis of data showed that scientists recommended this practice but farmers did not accept it as an effective method to control disease. This might be due to farmer’s misconception regarding salt solution that it reduces the seed germination. The practice of spraying neem (Azadirachta indica) oil to control powdery mildew in black gram crop was observed as irrational both by farmers and scientists. Other studies (Atte, 1991; Pamela, 1994; Gupta and Patel, 1992) also confirm such practices rational and sustainable. Small trenches digging around and in the field at various places to control hairy caterpillar may help to make barrier and larvae of hairy caterpillar fall down in tranches; and they can be destroyed easily. Deep summer ploughing during summer to control the various insects like pod borer and other soil born diseases, helps to expose spores of different soil born diseases and eggs of pod borer.

Dusting of ash at germination stage in controlling the house cricket and locust in mustard field was found to be rational and in line with the results reported by Sundaramari and Ranganothan (2003). Fumes of mustard oil and smoke may easily repel the insects. The practice of using neem leaf extract to control mustard sawfly could be irrational. As other study indicated that green neem leaves help to control Bihar hairy caterpillar (Dicrisia oblique) and other pests in soybean crop are in line with Yadav, et al. (2003). Earlier researches Rajasekaran et. al (1991), have revealed that neem based insecticides are effective to control pests. The remaining nine identified practices namely fumigating the moong crop with dhoop, hairs and one or two dead scorpion for heavy flowering; neem oil is used to control whiteflies and aphids; dried neem fruits are powdered and applied to control aphids, hoppers and white flies; growing cowpea as inter crop to control leaf miner in kharif
Table 1: Rationality status of identified indigenous plant protection practices as revealed by the farmers and scientists, respectively. (Sample size: Farmers N=180; Scientists N=40)

| ITK | Practices                                                                 | Rationality score by Farmers | Rationality score by Scientists |
|-----|---------------------------------------------------------------------------|------------------------------|--------------------------------|
|     |                                                                           | Total score | Mean score | Rationality status | Total score | Mean score | Rationality status | Z value  |
| A   | Disease                                                                 |
| 1   | Soaking of pearl millet seeds in salt solution to control the ergot disease. | 295          | 1.64       | IR                 | 196         | 4.90       | R                 | 36.22**  |
| 2   | Neem (*Azadirachta indica*) oil is sprayed to control powdery mildew in black gram crop. | 265          | 1.47       | IR                 | 105         | 2.62       | IR                | 12.78**  |
| B   | Insects                                                                 |
| 1   | Small trenches are dug around the field and in the field at various places to control hairy catter pillar. | 898          | 4.98       | R                   | 199         | 4.97       | R                 | 0.11 NS  |
| 2   | Deep summer ploughing is done to control the various insects like pod borer and various soil born diseases. | 879          | 4.88       | R                   | 190         | 4.75       | R                 | 0.44 NS  |
| 3   | Fix up the bird perches or broadcast the bajra seeds in gram field to encourage birds to control the insects attack. | 845          | 4.69       | R                   | 187         | 4.67       | R                 | 0.22 NS  |
| 4   | Diesel or kerosene is used to treat the seed of gram to control the attack of termite. | 805          | 4.47       | R                   | 172         | 4.30       | R                 | 0.89 NS  |
| 5   | Dusting of ash in the field to control aphids/thrips in moong and mustard. | 786          | 4.37       | R                   | 175         | 4.37       | R                 | 0.00 NS  |
| 6   | Crop residues are disposed off immediately after the harvest to reduce the pest and disease attack in next crop. | 752          | 4.18       | R                   | 186         | 0.65       | R                 | 0.22*    |
| 7   | Burning of crop residues and other debris in the night after the first rain of the monsoon to control the white ants, hairy catter pillar, white grub and termites in the fields | 738          | 4.10       | R                   | 177         | 4.43       | R                 | 0.67**   |
| 8   | Dusting of ash at germination stage to control the house cricket and locust in mustard field. | 736          | 4.09       | R                   | 150         | 3.75       | R                 | 0.78**   |
| 9   | Preparing the *pakoras* and *gulgulas* with the mustard oil in the field to reduce the attack of disease. | 685          | 3.80       | R                   | 89          | 2.23       | IR                | 17.44**  |
| 10  | Fumigating the moong crop with dhoop, hairs and one or two dead scorpion for heavy flowering. | 439          | 2.44       | IR                 | 87          | 2.18       | IR                | 0.89*    |
| 11  | Neem oil is used to control whiteflies and aphids. | 245          | 1.36       | IR                 | 104         | 2.60       | IR                | 13.78**  |
| 12  | Neem leaf extract is used to control mustard sawfly. | 303          | 1.68       | IR                 | 134         | 3.35       | R                 | 18.56**  |

Table 1 continue.....
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|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 13 | Dried neem fruits are powdered and applied to control aphids, hoppers and white flies. | 241 | 1.34 | IR | 56 | 1.50 | IR | 01.78 NS |
| 14 | Growing cowpea as intercrop to control leaf miner in kharif season. | 235 | 1.31 | IR | 49 | 1.23 | IR | 00.89 NS |
| 15 | Extract from tobacco (Nicitäna tabacum) leaves is sprayed to repel the insect. | 207 | 1.15 | IR | 40 | 1.00 | IR | 01.67 NS |
| 16 | About 600 gm of tobacco is soaked in water for 2-3 days, filter and spray to control white flies in moong. Garlic (Allium satívum) extract, neem and aak (Calotropis gigantean) or dhtura (Datura alba) extract are used for seed treatment to control various disease and termite attack. | 205 | 1.14 | IR | 43 | 1.08 | IR | 00.67 NS |
| 17 | Spraying neem seed kernel extract twice to control pod borers. | 199 | 1.11 | IR | 44 | 1.10 | IR | 00.11NS |
| 18 | Neem leaf extract is sprayed to repel moth, hopper and to kill larvae of many insects. | 200 | 1.11 | IR | 49 | 1.23 | IR | 01.33 NS |

C Stored pest

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 1 | Storing black gram by mixing them with sand. | 900 | 5.00 | R | 200 | 5.00 | R | 00.00 |
| 2 | Before storage the seeds of pearl millet are properly dried in sun. | 900 | 5.00 | R | 181 | 4.53 | R | 05.22** |
| 3 | Storing moong by mixing them with ash. | 876 | 4.87 | R | 195 | 4.88 | R | 00.11NS |
| 4 | Layer of neem leaves are spread at floor of the storage bin and another layer on top of the grains to protect them from pest. | 836 | 4.64 | R | 160 | 4.00 | R | 07.11** |
| 5 | Place match boxes at some distance in stored grains to protect them from insects. | 811 | 4.50 | R | 155 | 3.88 | IR | 06.89** |
| 6 | Regular whitewashing the storage structure reduce insect and pest infestation. | 700 | 3.89 | R | 136 | 3.40 | R | 05.44** |
| 7 | Disinfect the storage structure with smoke of dung cake and neem leaves before storing the grains. | 654 | 3.63 | R | 131 | 3.28 | R | 03.89** |
| 8 | Putting the tar coal sheets in between storage structure walls and under its floor to protect the grains from moisture. | 406 | 2.25 | IR | 112 | 2.80 | IR | 06.11** |

Table 1 continue.....
season; extract from tobacco (*Nicotiana tabacum*) leaves is sprayed to repel the insect; garlic (*Allium sativum*) extract, neem and aak (*Calotropis gigantean*) or dhtura (*Datura alba*) extract are used for seed treatment to control various disease and termite attack; spraying neem seed kernel extract twice to control pod borers; neem leaf extract is sprayed to repel moth, hopper and to kill larvae of many insects were observed to be irrational. The above finding contradicted with the finding of Sundaramari and Ranganothan (2003).

About 600 gm of tobacco is soaked in water for 2-3 days, filter and spray to control white flies in moong. Garlic (*Allium sativum*) extract, neem and aak (*Calotropis gigantean*) or dhtura (*Datura alba*) extract are used for seed treatment to control various disease and termite attack; spraying neem seed kernel extract twice to control pod borers; neem leaf extract is sprayed to repel moth, hopper and to kill larvae of many insects were observed to be irrational. The above finding contradicted with the finding of Sundaramari and Ranganothan (2003).

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The identified indigenous practices storing black gram by mixing them with sand; before storage the seeds of pearl millet are properly dried in sun, storing moong by mixing them with ash and layer of neem leaves are spread at floor of the storage bin and another layer on top of the grains to protect them from pest were perceived rational by both farmers and scientists. Singh (2001) found dry tobacco leaves effective to control larvae of *Heliothis armigera* in soybean crop. The practice spraying neem seed kernel extract twice to control pod borers and neem leaf extract is sprayed to repel moth, hopper and to kill larvae of many insects were perceived irrational by both farmers and scientists. Abraham *et al.* (1975)confirmed that neem leaves had possessed insect repellent properties.

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### Table 1

| **D** Birds | **Clapping of hands is done to drive away the birds.** | 890 | 4.94 | R | 187 | 4.68 | R | 02.89* |
| **Fixing a human effigy prepared from straw and old cloths in the field to scare the birds and animals.** | 884 | 4.91 | R | 186 | 4.65 | R | 02.89* |
| **Beating empty iron / plastic drum toward off birds.** | 875 | 4.86 | R | 181 | 4.53 | R | 03.67** |
| **Pieces of polythene sheet / metallic ribbon are tied on a pole and fixed in the field to produce sound to scare the birds.** | 859 | 4.77 | R | 183 | 4.58 | R | 02.11 NS |
| **Toward off birds small stones are thrown with the help of kavan.** | 846 | 4.70 | R | 189 | 4.73 | R | 00.33 NS |
| **Long whistling by mouth is done towards off birds.** | 846 | 4.70 | R | 183 | 4.58 | R | 01.33NS |
| **A black cloth is tied to a long pole and fixed at the centre of the field which drives away crows.** | 830 | 4.61 | R | 121 | 3.02 | R | 17.65** |
| **For birds scaring the carcass of a crow is hang on a pole in the field.** | 811 | 4.50 | R | 147 | 3.68 | R | 09.11** |

Note: ITK: Indigenous technical knowledge; IR: Irrational; R: Rational;* Significant at 0.05 percent probability level;**Significant at 0.01 percent probability level.
enhance the sustainability of agro ecosystems. An integrated approach of agricultural development is required where farmers use more number of indigenous plant protection practices. This integration could be in-between farmers, scientist, NGOs, and public sectors. There is need further to improvise some of the rational practices to reduce the volume and quantity of ingredients used for pest management. Whereas, the irrational practices on plant protection could be discouraged so as to farmers may improvise the agricultural production by opting other indigenous or scientifically proved organic practices.

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